STATE BOARD OF TECHNICAL EDUCATION, BIHAR
Scheme of Teaching and Examinations for
I[st] Semester
(Effective from Session 2020-21)
THEORY

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME Periods per Week			Hours of Exam.	Teacher's Assessment (TA) Marks (A)	Class Test(CT) Marks (B)	End Semester Exam. (ESE) Marks (C)	Total Marks (A+B+C)	Pass Marks ESE	Pass Marks in the Subject	Credits
			L	T	L+T								
1.	Mathematics-II	2002201	03	01	04	03	10	20	70	100	28	40	04
2.	Applied Physics-II	2002202	02	01	03	03	10	20	70	100	28	40	03
3.	Introduction to IT Systems	2002203	02	01	03	03	10	20	70	100	28	40	02
4.	Fundamental of Electrical & Electronics Engg.	2002204	02	01	03	03	10	20	70	100	28	40	03
5.	Engg. Mechanics	2002205	02	01	03	03	10	20	70	100	28	40	03
	Total:-		11	05	16				350	500			15

PRACTICAL

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME Periods per Week	Hours of Exam.	Practical Internal(PA)	Practical External(ESE)	Total Marks	Pass Marks in the Subject	Credits
6.	Applied Physics Lab-II	2002206	02	03	15	35	50	20	01
7.	Introduction to IT Systems Lab	2002207	04	03	15	35	50	20	02
8.	Fundamental of Electrical & Electronics Engg. Lab	2002208	04	03	15	35	50	20	01
9.	Engg. Mechanics Lab	2002209	03	03	15	35	50	20	02
	Total:-		13				200		06

TERM WORK

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME Periods per week	Marks of Internal (PA)	Marks of External (ESE)	Total Marks	Pass Marks in the Subject	Credits
10.	Course under MOOCS / SWAYAM / ETC / Others	2002210	-	06	14	20	08	02
11.	KYP/IT Essential/Python/Others	2002211	-	06	14	20	08	01
12.	Environmental Science	2002212	02	10	-	10	04	-
	Total:-		02			50		03

Total Periods per week Each of duration One Hours 31		**Total Marks = 750**	**24**

MATHEMATICS - II

Subject Code 2002201	Theory			No of Periods in One Session : 60			Credits
	No. of Periods Per Week			Full Marks	:	100	
	L	T	P/S	ESE	:	70	04
	03	01	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:

This course is designed to give a comprehensive coverage at an introductory level to the subject of Differential Calculus, Integral Calculus,First Order Differential Equations and Basic elements of vector algebra.

Course Content:

UNIT - I: Differential Calculus   [18]

Definition of function; Types of function & simple examples, Concept of limits. Four standard limits

$$\lim_{x \to a} \frac{x^n - a^n}{x-a}, \qquad \lim_{x \to 0} \frac{\sin x}{x}, \qquad \lim_{x \to a} \left(\frac{a^x - 1}{x}\right) \text{ and } \qquad \lim_{x \to a} (1+x)^{\frac{1}{x}}$$

Concept of Continuity (Simple Problems)

Differentiation bydefinition of $x^n, \sin x \cos x, \tan x$, e^x and $\log_a$ Differentiation of sum, product and quotient of functions. Differentiation of function of a function. Differentiation of trigonometric and inverse trigonometric functions, Logarithmic differentiation, Exponential functions. Differentiation ofimplicit and Parametric function. Differentiation of one function with respect to another function.

UNIT - II: Integral Calculus   [18]

Integration as inverse operation of differentiation. Simple integration by transformation, by substitution, by parts and by partial fractions(for linear factors only).Definite Integration & its properties,simple problems. Applications of integration for (i) Simple problem on evaluation of area bounded by a curve and axes. (ii) Area bounded by two curves .(Simple problems).

UNIT-III: Differential Equations   [08]

Definition of differential equations. Order and degree of a differential equation. Formation of differential equation. Solution of first order and first degree differential equation by variableseparation method (simple problems).MATLAB – Simple Introduction.

UNIT - IV: Vector Algebra   [16]

Definition, notation and rectangular resolution of a vector. Addition and subtraction of vectors. Scalar and vector products of 2 vectors. Simple problems related to work, moment and angular velocity.

References:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 40th Edition, 2007.

2. S.S. Sabharwal, Sunita Jain, Eagle Parkashan, Applied Mathematics, Vol. I & II,Jalandhar.

3. Comprehensive Mathematics, Vol. I & II by Laxmi Publications,Delhi.

4. Mathematics today XI & XII (Part I & II) by Lalji Prasad (Paramount Publication, GovindMitra Road)

5. A Text Book of Mathematics-XI & XII (Vol-1 & Vol-2) - by K.C. Sinha- Rastogi Publication, Meerut.

Course Outcomes:

By the end of the course the students are expected to learn

(i) the cumulative effect of the original quantity or equation is the Integration

(ii) Tell the difference between a resultant and a concurrent force to model simple physical problems in the form of a differential equation, analyze and interpret the solutions.

APPLIED PHYSICS -II

Subject Code 2002202	Theory			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	02	01	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives :-

Applied Physics aims to give an understanding of this world both by observation and by prediction of the way in which objects behave. Concrete use of physical principles and analysis in various fields of engineering and technology are given prominence in the course content. The course will help the diploma engineers to apply the basic concepts and principles to solve broad-based engineering problems and to understand different technology based applications.

Teaching Approach :-

Teachers should give examples from daily routine as well as, engineering/technology appli-cations on various concepts and principles in each topic so that students are able to understand and grasp these concepts and principles. In all contents, SI units should be followed. Use of demonstration can make the subject interesting and develop scientific temper in the students. Student activities should be planned on all the topics.

Activity- Theory - Demonstrate/practice approach may be followed throughout the course so that learning may be outcome and employability based.

Course Content :-

UNIT - 1: Wave motion and its applications [07]

Wave motion, transverse and longitudinal waves with examples, definitions of wave velocity, frequency and wave length and their relationship, Sound and light waves and their properties, wave equation ($y = r \sin \omega t$) amplitude, phase, phase difference, principle of superposition of waves and beat formation.

Simple Harmonic Motion (SHM): definition, expression for displacement, velocity, acceleration, time period, frequency etc. Simple harmonic progressive wave and energy transfer, study of vibration of cantilever and determination of its time period, Free, forced and resonant vibrations with examples.

Acoustics of buildings – reverberation, reverberation time, echo, noise, coefficient of absorption of sound, methods to control reverberation time and their applications, Ultrasonic waves – Introduction and properties, engineering and medical applications of ultrasonic.

UNIT - 2: Optics [07]

Basic optical laws; reflection and refraction, refractive index, Images and image formation by mirrors, lens and thin lenses, lens formula, power of lens, magnification and defects. Total internal reflection, Critical angle and conditions for total internal reflection, applications of total internal reflection in optical fiber.

Optical Instruments; simple and compound microscope, astronomical telescope in

normal adjustment, magnifying power, resolving power, uses of microscope and telescope, optical projection systems.

UNIT - 3: Electrostatics [06]

Coulombs law, unit of charge, Electric field, Electric lines of force and their properties, Electric flux, Electric potential and potential difference, Gauss law: Application of Gauss law to find electric field intensity of straight charged conductor, plane charged sheet and charged sphere. Capacitor and its working, Types of capacitors, Capacitance and its units. Capacitance of a parallel plate capacitor, Series and parallel combination of capacitors (related numerical), dielectric and its effect on capacitance, dielectric break down.

UNIT - 4: Current Electricity [06]

Electric Current and its units, Direct and alternating current, Resistance and its units, Specific resistance, Conductance, Specific conductance, Series and parallel combination of resistances. Factors affecting resistance of a wire, carbon resistances and color coding.

Ohm's law and its verification, Kirchhoff's laws, Wheatstone bridge and its applications (slide wire bridge only), Concept of terminal potential difference and Electro motive force (EMF) Heating effect of current, Electric power, Electric energy and its units (related numerical problems), Advantages of Electric Energy over other forms of energy.

UNIT - 5: Electromagnetism [06]

Types of magnetic materials; diamagnetic , Paramagnetic and ferromagnetic with their properties, Magnetic field and its units, magnetic intensity, magnetic lines of force, magnetic flux and units, magnetization. Concept of electromagnetic induction, Faraday's Laws, Lorentz force (force on moving charge in magnetic field). Force on current carrying conductor, force on rectangular coil placed in magnetic field. Moving coil galvanometer; principle, construction and working, Conversion of a galvanometer into ammeter and voltmeter.

UNIT - 6: Semiconductor Physics [06]

Energy bands in solids, Types of materials (insulator, semi-conductor, conductor), intrinsic and extrinsic semiconductors, p-n junction, junction diode and V-I characteristics, types of junction diodes. Diode as rectifier – half wave and full wave rectifier (centre taped).

Transistor; description and three terminals, Types- p-n-p and n-p-n, some electronic applications (list only). Photocells, Solar cells; working principle and engineering applications.

UNIT - 7: Modern Physics [07]

Lasers: Energy levels, ionization and excitation potentials; spontaneous and stimulated emission; population inversion, pumping methods, optical feedback, Types of lasers; Ruby, He-Ne and semiconductor, laser characteristics, engineering and medical applications of lasers.

Fiber Optics: Introduction to optical fibers, light propagation, acceptance angle and numerical aperture, fiber types, applications in; telecommunication, medical and sensors.

Nano-science and Nanotechnology: Introduction, nano-particles and nano-materials, properties at nano-scale, nanotechnology, nanotechnology based devices and applications.

Learning Outcome:

After undergoing this subject, the student will be able to;

a) Describe waves and wave motion, periodic and simple harmonic motions and solve simple problems. Establish wave parameters: frequency, amplitude, wavelength, and velocity and able to explain diffraction, interference, polarization of waves.

b) Explain ultrasonic waves and engineering, medical and industrial applications of Ultrasonics. Apply acoustics principles to various types of buildings for best sound effect.

c) State basic optical laws, establish the location of the images formed by mirrors and thin con- verging lens, design and assemble microscope using lenses combination.

d) Describe refractive index of a liquid or a solid and will be able to explain conditions for total internal reflection.

e) Define capacitance and its unit, explain the function of capacitors in simple circuits, and solve simple problems.

f) Differentiate between insulators, conductors and semiconductors, and define the terms: potential, potential difference, electromotive force.

g) Express electric current as flow of charge, concept of resistance, measure of the parameters: electric current, potential difference, resistance.

h) List the effects of an electric current and its common applications, State Ohm's law, calculate the equivalent resistance of a variety of resistor combinations, distinguish between AC and DC currents, determine the energy consumed by an appliance,

i) State the laws of electromagnetic induction, describe the effect on a current-carrying conductor when placed in a magnetic field.

j) Explain the operation of appliances like moving coil galvanometer, simple DC motors.

k) Apply the knowledge of diodes in rectifiers, power adapters and various electronic circuits. Use the knowledge of semiconductors in various technical gadgets like mobile phones, computers, LED, photocells, solar lights etc.

l) Illustrate the conditions for light amplification in various LASER and laser based instruments and optical devices.

m) Appreciate the potential of optical fiber in fields of medicine and communication.

n) Express importance of nanoscience and nanotechnology and impact of nanotechnology to the society.

References:

1. Text Book of Physics for Class XI& XII (Part-I, Part-II); N.C.E.R.T., Delhi

2. Applied Physics, Vol. I and Vol. II, TTTI Publications, Tata McGraw Hill, Delhi

3. Concepts in Physics by HC Verma, Vol. I & II, Bharti Bhawan Ltd. New Delhi

4. Engineering Physics by PV Naik, Pearson Education Pvt. Ltd, New Delhi.

5. Modern approach to Applied Physics-I and II, AS Vasudeva, Modern Publishers.

6. A Textbook of Optics, N Subramanyam, Brij Lal, MN Avahanulu, S Chand and Company Ltd.

7. Introduction to Fiber Optics, Ajoy Ghatak and K Thyagarajan, Cambridge University Press India Pvt. Ltd, New Delhi.

8. Nanoscience and Nanotechnology, KK Choudhary, Narosa Publishing House, Pvt. Ltd. New Delhi.

9. Nanotechnology: Importance and Applications, M.H. Fulekar, IK International Publishing House Pvt. Ltd, New Delhi.

10. e-books/e-tools/ learning physics software/websites etc.

INTRODUCTION TO IT SYSTEMS

Subject Code 2002203	Theory			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	100	
	L	T	P/S	ESE	:	70	02
	02	01	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:-

This course is intended to make new students comfortable with computing environment Learning basic computer skills, Learning basic application software tools, Understanding Computer Hardware, Cyber security awareness

Course Content:-

UNIT 1: Basic Internet skills: Understanding browser, efficient use of search engines, awareness about Digital India portals (state and national portals) and college portals.
General understanding of various computer hardware components – CPU, Memory, Display, Keyboard, Mouse, HDD and other Peripheral Devices.

UNIT 2: OS Installation (Linux and MS Windows), Unix Shell and Commands, vi editor.

UNIT 3: HTML4, CSS, making basic personal webpage.

UNIT 4: Office Tools: Open Office Writer, Open Office Spreadsheet (Calc), Open Office Impress.

UNIT 5: Information security best practices. Class lectures will only introduce the topic or demonstrate the tool, actual learning will take place in the Lab by practicing regularly.

Suggested Lab Work:

This is a skill course. Topics/concepts taught in the class should be practiced in the Lab same week and practiced regularly during the semester till student becomes confident about it. This course is all about some theory and a lot of practice.

References:

- R.S. Salaria, Computer Fundamentals, Khanna Publishing House

- Ramesh Bangia, PC Software Made Easy – The PC Course Kit, Khanna Publishing House

- Online Resources, Linux man pages, Wikipedia

- Mastering Linux Shell Scripting: A practical guide to Linux command-line, Bash scripting, and Shell programming, by Mokhtar Ebrahim, Andrew Mallett

Course outcomes:

At the end of the course student will be able to comfortably work on computer, install and configure OS, assemble a PC and connect it to external devices, write documents, create worksheets, prepare presentations, protect information and computers from basic abuses/ attacks.

FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING

Subject Code 2002204	Theory		No of Periods in One Session : 45			Credits
	No. of Periods Per Week		Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	02	01	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:-

To provide basic knowledge of the different elements and concepts of electrical engineering field and to learn basic concepts of various active and passive electronic components, Signals, Op-Amp and their applications, Digital Electronics and their applications to help students deal with electrical and electronics engineering principles and applications in industrial processes of different fields.

Course Content:-

UNIT- I Overview of Electronic Components & Signals:

Passive Active Components: Resistances, Capacitors, Inductors. Basic Concept of Diodes, Transistors, FET, MOS and CMOS and their Applications. Signals: DC / AC, voltage / current, periodic / non-periodic signals, Ideal / non-ideal voltage / current sources, independent / dependent voltage current sources.

UNIT- II Overview of Analog Circuits:

Operational Amplifiers-Ideal Op-Amp, Practical op amp, Open loop and closed loop configurations, Application of Op-Amp as amplifier, adder, differentiator and integrator.

UNIT- III Overview of Digital Electronics:

Introduction to Boolean Algebra, Electronic Implementation of Boolean Operations, Gates-Functional Block Approach,

UNIT - IV Electric and Magnetic Circuits:

EMF, Current, Potential Difference, Power and Energy; M.M.F, magnetic force, permeability, hysteresis loop, reluctance, leakage factor and BH curve; Electromagnetic induction, Faraday's laws of electromagnetic induction, Lenz's law; Dynamically induced emf; Statically induced emf; Equations of self and mutual inductance; Analogy between electric and magnetic circuits.

UNIT - V A.C. Circuits:

Cycle, Frequency, Periodic time, Amplitude, Angular velocity, RMS value, Average value, Form Factor Peak Factor, impedance, phase angle, and power factor KCL and KVL Mathematical and phasor representation of alternating emf and current; Voltage and Current relationship in Star and Delta connections; A.C in resistors, inductors and capacitors; A.C in R-L series, R-C series, R-L-C series Circuits.

UNIT VI Transformer and Machines: General construction and principle of different type of

transformers; Emf equation and transformation ratio of transformers; Auto transformers; Construction and Working principle of motors; Basic equations and characteristic of motors.

References:

1. Ritu Sahdev, Basic Electrical Engineering, Khanna Publishing House

2. Mittle and Mittal, Basic Electrical Engineering, McGraw Education, New Delhi, 2015, ISBN : 978-0-07-0088572-5

3. Saxena, S. B. Lal, Fundamentals of Electrical Engineering, Cambridge University Press, latest edition ISBN : 9781107464353

4. Theraja, B. L., Electrical Technology Vol – I, S. Chand Publications, New Delhi, 2015, ISBN: 9788121924405

5. Theraja, B. L., Electrical Technology Vol – II, S. Chand Publications, New Delhi, 2015, ISBN: 9788121924375

6. Jegathesan, V., Basic Electrical and Electronics Engineering, Wiley India, New Delhi, 2015, ISBN : 97881236529513

7. Sedha, R.S., A text book of Applied Electronics, S.Chand, New Delhi, 2008, ISBN-13: 978-8121927833

8. Malvino, Albert Paul, David, Electronics Principles, McGraw Hill Education, New Delhi,2015, ISBN-13**:** 0070634244-978

9. Mehta, V.K., Mehta, Rohit, Principles of Electronics, S. Chand and Company, New Delhi, 2014, ISBN-13-9788121924504

10. Bell Devid, Fundamental of Electronic Devices and Circuits, Oxford University Press, New Delhi 2015 ISBN : 9780195425239

ENGINEERING MECHANICS

Subject Code 2002205	Theory			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	02	01	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:-

Following are the objectives of this course:

1) To obtain resultant of various forces

2) To calculate support reactions through conditions of equilibrium for various structures

3) To understand role of friction in equilibrium problems

4) To know fundamental laws of machines and their applications to various engineering problems

Course Contents:-

UNIT – I Basics of mechanics and force system [11]

Significance and relevance of Mechanics, Applied mechanics, Statics, Dynamics. Space, time, mass, particle, flexible body and rigid body. Scalar and vector quantity, Units of measurement (SI units) - Fundamental units and derived units.

Force – unit, representation as a vector and by Bow's notation, characteristics and effects of a force, Principle of transmissibility of force, Force system and its classification.

Resolution of a force - Orthogonal components of a force, moment of a force, Varignon's Theorem.

Composition of forces – Resultant, analytical method for determination of resultant for concurrent, non-concurrent and parallel co-planar force systems – Law of triangle, parallelogram and polygon of forces.

UNIT– II Equilibrium [10]

Equilibrium and Equilibrant, Free body and Free body diagram, Analytical and graphical methods of analysing equilibrium Lami's Theorem – statement and explanation, Application for various engineering problems. Types of beam, supports (simple, hinged, roller and fixed) and loads acting on beam (vertical and inclined point load, uniformly distributed load, couple), Beam reaction for cantilever, simply supported beam with or without overhang – subjected to combination of Point load and uniformly distributed load. Beam reaction graphically for simply supported beam subjected to vertical point loads only.

UNIT– III Friction [06]

Friction and its relevance in engineering, types and laws of friction, limiting equilibrium, limiting friction, co-efficient of friction, angle of friction, angle of repose, relation between co-efficient of friction and angle of friction.

Equilibrium of bodies on level surface subjected to force parallel and inclined to

plane. Equilibrium of bodies on inclined plane subjected to force parallel to the plane only.

UNIT– IV Centroid and centre of gravity [08]

Centroid of geometrical plane figures (square, rectangle, triangle, circle, semicircle, quarter circle) Centroid of composite figures composed of not more than three geometrical figures Centre of Gravity of simple solids (Cube, cuboid, cone, cylinder, sphere, hemisphere) Centre of Gravity of composite solids composed of not more than two simple solids.

UNIT – V Simple lifting machine [10]

Simple lifting machine, load, effort, mechanical advantage, applications and advantages. Velocity ratio, efficiency of machines, law of machine. Ideal machine, friction in machine, maximum Mechanical advantage and efficiency, reversible and non-reversible machines, conditions for reversibility Velocity ratios of Simple axle and wheel, Differential axle and wheel, Worm and worm wheel, Single purchase and double purchase crab winch, Simple screw jack, Weston's differential pulley block, geared pulley block.

Suggested Learning Resources:

1. D.S. Bedi, Engineering Mechanics, Khanna Publications, New Delhi (2008)

2. Khurmi, R.S., Applied Mechanics, S. Chand & Co. New Delhi.

3. Bansal R K, A text book of Engineering Mechanics, Laxmi Publications.

4. Ramamrutham, Engineering Mechanics, S. Chand & Co. New Delhi.

5. Dhade, Jamadar & Walawelkar, Fundamental of Applied Mechanics, Pune Vidhyarthi Gruh.

6. Ram, H. D.; Chauhan, A. K., Foundations and Applications of Applied Mechanics, Cam- bridge University Press.

7. Meriam, J. L., Kraige, L.G., Engineering Mechanics- Statics, Vol. I, Wiley Publication, New Delhi.

Course outcomes:

After completing this course, student will be able to:

1. Identify the force systems for given conditions by applying the basics of mechanics.

2. Determine unknown force(s) of different engineering systems.

3. Apply the principles of friction in various conditions for useful purposes.

4. Find the centroid and centre of gravity of various components in engineering systems.

5. Select the relevant simple lifting machine(s) for given purposes.

APPLIED PHYSICS LAB II

Subject Code 2002206	Practical			No of Periods in One Session : 30			Credits
	No. of Periods Per Week			Full Marks	:	50	01
	L	T	P/S	Internal(PA)	:	15	
	-	-	02	External(ESE)	:	35	
	-	-	-	-	:	-	

Course Objectives:

Concrete use of physical principles and analysis in various fields of engineering and technology is very prominence. The course aims to supplement the factual knowledge gained in the lecture by first hand manipulation of apparatus. This will develop scientific temper and help to apply the basic concepts and principles in solving engineering and technology based problems. In addition, students get necessary confidence in handling equipment and thus learn various skills in measurement.

List of Practical's (To perform minimum 12 Practical's)

1. To determine and verify the time period of a cantilever.

2. To determine velocity of ultrasonic in different liquids using ultrasonic interferometer.

3. To verify laws of reflection from a plane mirror/ interface.

4. To verify laws of refraction (Snell's law) using a glassslab.

5. To determine focal length and magnifying power of a convex lens.

6. To verify Ohm's law by plotting graph between current and potential difference.

7. To verify laws of resistances in series and parallel combination.

8. To find the frequency of AC main using electrical vibrator.

9. To verify Kirchhoff's law using electric circuits.

10. To study the dependence of capacitance of a parallel plate capacitor on various factors and determines permittivity of air at a place.

11. To find resistance of a galvanometer by half deflection method.

12. To convert a galvanometer into an ammeter.

13. To convert a galvanometer into a voltmeter.

14. To draw V-I characteristics of a semiconductor diode (Ge, Si) and determine its knee voltage.

15. To verify inverse square law of radiations using a photo-electric cell.

16. To measure wavelength of a He-Ne/diode laser using a diffraction grating.

17. To measure numerical aperture (NA) of an optical fiber.

18. Study of an optical projection system (OHP/LCD) - project report.

Suggested Student Activities & Strategies :-

Apart from classroom and laboratory learning following are the suggested student related activities which can be undertaken to accelerate the attainment of various outcomes of the course.

a. Make survey of different physical products and compare the following points

- Measurements of dimensions
- Properties
- Applications

b. Library survey regarding engineering materials/products used in different industries

c. Seminar on any relevant topic.

Teachers should use the following strategies to achieve the various outcomes of the course.

- Different methods of teaching and media to be used to attain classroom attention.

- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.

- 15-20% of the topics which are relatively simpler or descriptive in nature should be given to the students for self-learning and assess the development of competency through classroom presentations/projects.

- Micro-projects on relevant may be given to group of students for hand-on experiences.

  Learning Outcome:

After undergoing this subject, the student will be able to;

a) Apply concept of vibrations and determine the time period of vibrating objects.

b) *Use of equipment for determining velocity of ultrasonics in different liquids.*

c) Verify optical laws; reflection, refraction from plane interfaces and surfaces.

d) Apply knowledge of optics to determine focal length and magnifying power of optical lenses.

e) Understand uses of electrical components and meters and verify Ohm's law for flow of current.

f) Quantify resistances and verify laws of series and parallel combination of resistances.

g) Apply concept of electrical vibrations in determine frequency of AC main.

h) Analyse electrical circuits and verify Kirchhoff's law governing electrical circuits.

i) Measure resistance of a galvanometer and how it is converted into an ammeter and voltmeter.

j) Investigate characteristics of semiconductor diodes, photoelectric cells and determine operational parameters associated with their performance.

k) Work with laboratory lasers and understand method to measure the wavelength of the light emitted from a laser.

l) Handle optical fibers and determine numerical aperture of given optical fiber.

m) Understand construction and working of an optical projection system.

Recommended Books:

1. Text Book of Physics for Class XI& XII (Part-I, Part-II); N.C.E.R.T., Delhi

2. Comprehensive Practical Physics, Vol, I & II, JN Jaiswal, Laxmi Publications (P) Ltd., New Delhi

3. Practical Physics by C. L. Arora, S. Chand & Company Ltd.

4. e-books/e-tools/ learning physics software/you Tube videos/ websites etc.

INTRODUCTION TO IT SYSTEMS LAB

Subject Code 2002207	Practical			No of Periods in One Session : 60			Credits
	No. of Periods Per Week			Full Marks	:	50	
	L	T	P/S	Internal(PA)	:	15	02
	-	-	04	External(ESE)	:	35	
	-	-	-	-	:	-	

Course Objectives: -

This Lab course is intended to practice whatever is taught in theory class of 'Introduction of IT Systems' and become proficient in using computing environment - basic computer skills, basic application software tools, Computer Hardware, cyber security features, etc.

Course Content: -

S.No.   Topics for Practice

1   Browser features, browsing, using various search engines, writing search queries

2   Visit various e-governance/Digital India portals, understand their features, services offered

3   Read Wikipedia pages on computer hardware components, look at those components in lab, identify them, recognize various ports/interfaces and related cables, etc.

4   Install Linux and Windows operating system on identified lab machines, explore various options, do it multiple times

5   Connect various peripherals (printer, scanner, etc.) to computer, explore various features of peripheral and their device driver software.

6   Practice HTML commands, try them with various values, make your own Webpage

7   Explore features of Open Office tools, create documents using these features, do it multiple times

8   Explore security features of Operating Systems and Tools, try using them and see what happens.

This is a skill course. More you practice, better it will be.

References:

1. Online resources, Linux man pages, Wikipedia.
2. R.S. Salaria, Computer Fundamentals, Khanna Publishing House.
3. Ramesh Bangia, PC Software Made Easy – The PC Course Kit, Khanna Publishing House.
4. Mastering Linux Shell Scripting: A practical guide to Linux command-line, Bash scripting, and Shell programming, by Mokhtar Ebrahim, Andrew Mallett.
5. IT Essentials PC Hardware and Software Companion Guide, Davis Anfinson and Ken Quamme, CISC Press, Pearson Education.
6. PC Hardware and A+ Handbook, Kate J. Chase PHI (Microsoft).

Course outcomes:-

At the end of the course student will be able to comfortably work on computer, install and configure OS, assemble a PC and connect it to external devices, write documents, create worksheets, prepare presentations, protect information and computers from basic abuses/attacks.

FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING LAB

Subject Code 2002208	Practical			No of Periods in One Session : 60			Credits
	No. of Periods Per Week			Full Marks	:	50	
	L	T	P/S	Internal(PA)	:	15	01
	-	-	04	External(ESE)	:	35	
	-	-	-	-	:	-	

Suggested Practicals/Exercises:

The practical in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Approx. Hrs.
1.	Determine the permeability of magnetic material by plotting its B-H curve.	05
2.	Measure voltage, current and power in 1-phase circuit with resistive load.	05
3.	Measure voltage, current and power in R-L series circuit.	05
4.	Determine the transformation ratio (K) of 1-phase transformer.	05
5.	Connect single phase transformer and measure input and output quantities.	05
6.	Make Star and Delta connection in induction motor starters and measure the line and phase values.	05
7.	Identify various passive electronic components in the given circuit	05
8.	Connect resistors in series and parallel combination on bread board and measure its value using digital multimeter.	05
9.	Connect capacitors in series and parallel combination on bread board and measure its value using multimeter.	05
10.	Use multimeter to measure the value of given resistor.	05
11.	Determine the value of given resistor using digital multimeter to confirm with colour code.	05
12.	Test the PN-junction diodes using digital multimeter.	05
	Total	**60**

References:

1. Ritu Sahdev, Basic Electrical Engineering, Khanna Publishing House, 2018

2. Mittle and Mittal, Basic Electrical Engineering, McGraw Education, New Delhi, 2015, ISBN : 978-0-07-0088572-5

3. Saxena, S. B. Lal, Fundamentals of Electrical Engineering, Cambridge University Press, latest edition ISBN : 9781107464353

4. Theraja, B. L., Electrical Technology Vol – I, S. Chand publications, New Delhi, 2015, ISBN: 9788121924405

5. Theraja, B. L., Electrical Technology Vol – II, S. Chand publications, New Delhi, 2015, ISBN: 9788121924375

6. Jegathesan, V., Basic Electrical and Electronics Engineering, Wiley India, New Delhi, 2015, ISBN : 97881236529513

7. Sedha, R.S., A text book of Applied Electronics, S.Chand ,New Delhi, 2008, ISBN-13: 978-8121927833

8. Malvino, Albert Paul, David, Electronics Principles, McGraw Hill Eduction, New Delhi,2015, ISBN-13: 0070634244-978

9. Mehta, V.K., Mehta, Rohit, Principles of Electronics, S. Chand and Company, New Delhi, 2014, ISBN-13-9788121924504

10. Bell Devid, Fundamental of Electronic Devices and Circuits, Oxford University Press, New Delhi 2015 ISBN : 9780195425239

Suggested Softwares/Learning Websites:

a. en.wikipedia.org/wiki/Transformer

b. www.animations.physics.unsw.edu.au//jw/AC.html

c. www.alpharubicon.com/altenergy/understandingAC.htm

d. www.electronics-tutorials

e. learn.sparkfun.com/tutorials/transistors

f. www.pitt.edu/~qiw4/Academic/ME2082/Transistor%20Basics.pdf

g. www.technologystudent.com/elec1/transis1.htm

h. www.learningaboutelectronics.com

i. www.electrical4u.com

Course Outcomes:

At the end of the course student will be able to:

1. Understand basic principle and operation of electric circuits and machines.

2. Solve basic problems related to electrical circuits and machines. Explain the operation of different electrical technologies.

3. Demonstrate an understanding of the control systems.

4. Understand the basic circuit elements

5. Understand different types of signal waveforms.

6. Understand logic gates and apply them in various electronic circuits.

7. Understand the basic concepts of op-amps, and their applications.

8. Use relevant electric/electronic protective devices safely.

ENGINEERING MECHANICS LAB.

Subject Code 2002209	Practical			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal(PA)	:	15	
	-	-	03	External(ESE)	:	35	
	-	-	-	-	:	-	

Course Objectives:

Following are the objectives of this course:

1) To obtain resultant of various forces

2) To calculate support reactions through conditions of equilibrium for various structures

3) To understand role of friction in equilibrium problems

4) To know fundamental laws of machines and their applications to various engineering problems

List of Practical to be performed (Perform any 10 Practicals) :

1. Determine resultant of concurrent force system applying Law of Polygon of forces using force table.

2. Verify Lami's theorem.

3. Study forces in various members of Jib crane.

4. Determine support reactions for simply supported beam.

5. Determine coefficient of friction for motion on horizontal and inclined plane.

6. Determine centroid of geometrical plane figures.

7. To find the M.A., V.R., Efficiency and law of machine for Simple Screw Jack.

8. To find the M.A., V.R., Efficiency and law of machine for Differential Axle and Wheel.

9. Derive Law of machine using Worm and worm wheel.

10. Derive Law of machine using Single purchase crab.

11. Derive Law of machine using double purchase crab.

12. Derive Law of machine using Weston's differential or wormed geared pulley block.

Suggested Learning Resources:

1. Bedi D.S., Engineering Mechanics, Khanna Publishing House

2. Khurmi, R.S., Applied Mechanics, S.Chand & Co. New Delhi.

3. Bansal R K, A text book of Engineering Mechanics, Laxmi Publications.

4. Ramamrutham, Engineering Mechanics, S.,S Chand & Co. New Delhi.

5. Dhade, Jamadar & Walawelkar, Fundamental of Applied Mechanics, Pune Vidhyarthi Gruh.

6. Ram, H. D.; Chauhan, A. K. Foundations and Applications of Applied Mechanics, Cambridge Uni- versity Press.

7. Meriam, J. L., Kraige, L.G. , Engineering Mechanics- Statics, Vol. I, Wiley Publication, New Delhi.

Course outcomes:

After completing this course, student will be able to

1. Identify the force systems for given conditions by applying the basics of mechanics.

2. Determine unknown force(s) of different engineering systems.

3. Apply the principles of friction in various conditions for useful purposes.

4. Find the centroid and centre of gravity of various components in engineering systems.

5. Select the relevant simple lifting machine(s) for given purposes.

COURSE UNDER MOOCS / SWAYAM / ETC / OTHERS

Subject Code 2002210	Term Work			No of Periods in One Session :			Credits
	No. of Periods Per Week			Full Marks	:	20	
	L	T	P/S	Internal(PA)	:	06	02
	-	-	-	External(ESE)	:	14	
	-	-	-	-	:	-	

KYP / IT ESSENTIAL / PYTHON / OTHERS

Subject Code 2002211	Term Work			No of Periods in One Session :			Credits
	No. of Periods Per Week			Full Marks	:	20	01
	L	T	P/S	Internal	:	06	
	-	-	-	External Comm.	:	14	
	-	-	-	-	:	-	

ENVIRONMENTAL SCIENCE

Subject Code 2002212	Term Work			No of Periods in One Session : 30			Credits
	No. of Periods Per Week			Full Marks	:	10	
	L	T	P/S	Internal(PA)	:	10	-
	-	-	02		:	-	
	-	-	-	-	:	-	

Course Objectives:

Technicians working in industries or elsewhere essentially require the knowledge of environmental science so as to enable them to work and produce most efficient, economical and eco-friendly finished products.

- Solve various engineering problems applying ecosystem to produce eco – friendly products.

- Use relevant air and noise control method to solve domestic and industrial problems.

- Use relevant water and soil control method to solve domestic and industrial problems.

- To recognize relevant energy sources required for domestic and industrial applications.

Course Content:

Pre requisite: - High School Chemistry

ENVIRONMENTAL SCIENCE

UNIT-1 Environmental Studies :

Definition of Environment, Components of Environment, Biotic and Abiotic Components, Layers **[06]** of Atmosphere, Greenhouse Effect and Global Warming, Ozone Layer-Earth's Protective Umbrella, Depletion of Ozone Layer. Consequences of Ozone Depletion.

UNIT– 2 Water Pollution and Soil Pollution

Introduction, Sources of Water Pollution, Effects of Water Pollution, Control of Water **[07]** Pollution, Oxygen Demanding Waste, Determination of Dissolved Oxygen, Turbidity, pH, Biological Oxygen Demand, Chemical Oxygen Demand. Soil Pollution: Introduction, Composition of the Soil, Types of Soil, Causes, Effects and control of Soil Pollution.

UNIT- 3 Air Pollution and Noise Pollution :

Introduction, Composition of Air, Causes and effects of Air Pollution, Primary and **[07]** Secondary Pollutants, Control of Air Pollution, Acid Rain, Harmful effects of Acid Rain. Smog and its kind, Difference between Classical smog and Photochemical Smog. Causes and effects of Noise Pollution.

UNIT– 4 Radioactive Pollution :   [06]

Introduction, Kind of Radiation, Law of Radioactivity Decay, Mass Defect and Binding Energy, Nuclear Fission and Fusion, Harmful effects of Radiation.

UNIT-5 Renewable Sources of Energy :   [04]

Introduction of Solar Energy, Wind Energy, Tidal Energy, Biogas.

References:

(a)   **Suggested Learning Resources:**

        Books:

1   S.C. Sharma & M.P. Poonia, Environmental Studies, Khanna Publishing House, New Delhi

2.   C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.

3.   Arceivala, Soli Asolekar, Shyam, Waste Water Treatment for Pollution Control and

4.   Reuse, Mc-Graw Hill Education India Pvt. Ltd., New York, 2007, ISBN:978-07-062099-

5.   Nazaroff, William, Cohen, Lisa, Environmental Engineering Science, Willy, New York, 2000, ISBN 10: 0471144940.

6.   O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House, New Delhi

7.   Rao, C. S., Environmental Pollution Control and Engineering, New Age International Publication, 2007, ISBN: 81-224-1835-X.

8.   Rao, M. N.Rao, H.V.N, Air Pollution, Tata Mc-Graw Hill Publication, New delhi, 1988, ISBN: 0-07- 451871-8.

9.   Frank Kreith, Jan F Kreider, Principles of Solar Engineering, McGraw-Hill, New York ; 1978, ISBN: 9780070354760.

10.   Aldo Vieira, Da Rosa, Fundamentals of renewable energy processes, Academic Press Oxford, UK; 2013. ISBN: 9780123978257.

11.   Patvardhan, A.D, Industrial Solid Waste, Teri Press, New Delhi, 2013, ISBN:978-81-7993-502-6

12.   Metcalf & Eddy, Waste Water Engineering, Mc-Graw Hill, New York, 2013, ISBN: 077441206.

        Keshav Kant, Air Pollution & Control, Khanna Publishing House, New Delhi (Edition 2018)

(a) Open source software and website address :

1) www.eco-prayer.org

2) www.teriin.org

3) www.cpcp.nic.in

4) www.cpcp.gov.in

5) www.indiaenvironmentportal.org.in

6) www.whatis.techtarget.com

7) www.sustainabledevelopment.un.org

8) www.conserve-energy-future.com)

Teachers should use the following strategies to achieve the various outcomes of the course.

- Different methods of teaching and media to be used to attain classroom attention.

- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.

- 15-20% of the topics which are relatively simpler of descriptive in nature should be given to the students for self-learning and assess the development of competency through classroom presentations.

- Micro-projects may be given to group of students for hand-on experiences

- Encouraging students to visit to sites such as Railway station and research establishment around the institution.

Course outcomes

At the end of the course student will be able to

1. Understand the ecosystem and terminology and solve various engineering

   problems applying ecosystem knowledge to produce eco – friendly products.

2. Understand the suitable air, extent of noise pollution, and control measures and acts.

3. Understand the water and soil pollution, and control measures and acts.

4. Understand different renewable energy resources and efficient process of harvesting.

STATE BOARD OF TECHNICAL EDUCATION, BIHAR
Scheme of Teaching and Examinations for
IInd Semester
(Effective from Session 2020-21)
THEORY

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME			EXAMINATION – SCHEME							Credits
			Periods per Week			Hours of Exam.	Teacher's Assessment (TA) Marks (A)	Class Test(CT) Marks (B)	End Semester Exam. (ESE) Marks (C)	Total Marks (A+B+C)	Pass Marks ESE	Pass Marks in the Subject	
			L	T	L+T								
1.	Mathematics-I	2001101	02	01	03	03	10	20	70	100	28	40	03
2.	Applied Physics-I	2001102	02	01	03	03	10	20	70	100	28	40	03
3.	Applied Chemistry	2001103	02	01	03	03	10	20	70	100	28	40	03
4.	Communication Skills in English	2001104	02	-	02	03	10	20	70	100	28	40	02
5.	Engg. Graphics	2001105	03		03	03	10	20	70	100	28	40	02
		Total:-	11	03	14				350	500			13

PRACTICAL

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME	Hours of Exam.	EXAMINATION – SCHEME		Total Marks	Pass Marks in the Subject	Credits
			Periods per Week		Practical				
					Internal(PA)	External(ESE)			
6.	Applied Physics Lab-I	2001106	03	03	15	35	50	20	02
7.	Applied Chemistry Lab	2001107	03	03	15	35	50	20	02
8.	Communication Skills in English Lab	2001108	03	03	15	35	50	20	02
		Total:-	09				150		06

TERM WORK

Sr. No.	SUBJECTS	SUBJECT CODE	TEACHING SCHEME	EXAMINATION – SCHEME		Total Marks	Pass Marks in the Subject	Credits
			Periods per week	Marks of Internal (PA)	Marks of External (ESE)			
9.	Engg. Workshop Practice	2001109	06	07	18	25	10	02
10.	Sports and Yoga	2001110	02	07	18	25	10	02
11.	C/KYP/IT Essential / Python/ Others	2001111	-	15	35	50	20	01
		Total:-	08			100		05
Total Periods per week Each of duration One Hour **31**				**Total Marks = 750**				**24**

MATHEMATICS-I

Subject Code 2001101	Theory			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	02	01	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:

This course is designed to give a comprehensive coverage at an introductory level to the subject of Trigonometry, Co-ordinate Geometry, Basic elements of algebra and Matrices.

Course Content:

UNIT - I: Trigonometry [09]

Concept of angles, measurement of angles in degrees, grades and radians and their conversions, T-Ratios of Allied angles (without proof), Sum, difference formulae and their applications (without proof). Product formulae (Transformation of product to sum, difference and vice versa).T- Ratios of multiple angles, sub-multiple angles (2A, 3A, A/2). Graphs of sin x, cos x, tan x and e^x.Concept of inverse circular function.

UNIT - II: Co-Ordinate Geometry [17]

Equation of straight line in various standard forms (without proof), intersection of two straight lines,

Angle between two lines. Parallel and perpendicular lines, perpendicular distance formula.

General equation of a circle and its characteristics. To find the equation of a circle, given:

i. Centre andradius,

ii. Three points lying on itand

iii.   Coordinates of end points of adiameter;

Definition of conics (Parabola, Ellipse, Hyperbola) their standard equations (without proof). Problems on conics when their foci, directories or vertices are given.

UNIT - III: Algebra

ComplexNumbers: Definition,realandimaginarypartsofaComplexnumber,polarandcartesian **[04]** representation of a complex number and its conversion from one form to other, conjugate of a complexnumber,modulusandamplitudeofacomplexnumber.Addition,Subtraction,Multiplicationand Division of complex numbers,De-moivre's theorem (without proof)and itsapplication.

Partial fractions: Definition of polynomial fraction, proper & improper fractions and definition **[03]** of partial fractions. To resolve proper fraction into partial fraction with denominator containing non-repeated linear factors, repeated linear factors and irreducible non-repeated quadratic factors. To resolve improper fraction into partialfraction.

Permutations and Combinations: Definition of Factorial Notation, Introduction of **[02]** Permutation & Combination,Value of ^nP_r and ^nC_r.

Binomial Theorem: Binomial theorem (without proof) for positive integral index (expansion **[04]** and general form); binomial theorem for any index (expansion without proof) first and second

binomial approximation with applications to engineering problems

Determinants and Matrices [06]

Elementary properties of determinants up to 3rd order, consistency of equations, Crammer's rule.Algebraofmatrices, Transpose of a matrix, Adjoint of a matrix, Inverseofamatrix, (by adjoint method),matrixinversemethodtosolveasystemoflinearequations in2 or 3variables.

References:

1. B.S.Grewal,HigherEngineeringMathematics,KhannaPublishers,NewDelhi,40th Edition,2007.
2. ReenaGarg,EngineeringMathematics,KhannaPublishingHouse,NewDelhi(RevisedEd.2018)
3. Mathematics Today - XI & XII (Part I) byLalji Prasad (Paramount Publication, GovindMitra Road).
4. A Text Book of Mathematics-XI & XII (Vol-1) by K.C. Sinha-Rastogi Publication, Meerut
5   ReenaGarg&ChandrikaPrasad,AdvancedEngineeringMathematics,Khanna PublishingHouse, New Delhi

Course Outcomes:

By the end of the course, the students are expected to learn

(i) The students are expected to acquire necessary background in Trigonometry to appreciatethe importance of the geometric study as well as for the calculation and the mathematical analysis.

(ii) The ability to find the effects of changing conditions on asystem.

(iii) thecoordinategeometryprovidesaconnectionbetweenalgebraandgeometrythrough graphs of lines andcurves.

(iv) Complexnumbersenterintostudiesofphysicalphenomenainwaysthatmostpeoplecannot imagine.

(v) The students are expected to acquire necessary background in Determinants and Matrices so as to appreciate the importance of the Determinants are the factors that scale different parameterizations so that they all produce same overall integrals, i.e. they are capable of encoding the inherent geometry of the originalshape.

APPLIED PHYSICS-I

Subject Code 2001102	Theory			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	02	01	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:

Applied Physics includes the study of a large number of diverse topics all related to materials/things that exist in the world around us. It aims to give an understanding of this world both by observation and by prediction of the way in which such objects behave. Concrete use of physical principles and analysis in various fields of engineering and technology are given prominence in the course content. The course will help the diploma engineers to apply the basic concepts and principles to solve broad- based engineering problems and to understand different technology based applications.

Teaching Approach:

- Teachers should give examples from daily routine as well as, engineering/technology applications on various concepts and principles in each topic so that students are able to understand and grasp these concepts and principles. In all contents, SI units should be followed.

- Use of demonstration can make the subject interesting and develop scientific temper in the students. Student activities should be planned on all the topics.

- Activity- Theory - Demonstrate/practice approach may be followed throughout the course so that learning may be outcome and employability based.

Course Content:

Unit 1: **Physical world, Units and Measurements** [05]

Physical quantities; fundamental and derived, Units and systems of units (FPS, CGS and SI units), Dimensions and dimensional formulae of physical quantities, Principle of homogeneity of dimensions, Dimensional equations and their applications (conversion from one system of units to other, checking of dimensional equations and derivation of simple equations), Limitations of dimensional analysis.

Measurements: Need, measuring instruments, least count, types of measurement (direct, indirect), Errors in measurements (systematic and random), absolute error, relative error, error propagation, error estimation and significant figures.

Unit 2: **Force and Motion** [09]

Scalar and Vector quantities – examples, representation of vector, types of vectors. Addition and Subtraction of Vectors, Triangle and Parallelogram law (Statement only), Scalar and Vector Product, Resolution of a Vector and its application to inclined plane and lawn roller.

Force, Momentum, Statement and derivation of conservation of linear momentum, its applications such as recoil of gun, rockets, Impulse and its applications.

Circular motion, definition of angular displacement, angular velocity, angular acceleration, frequency, time period, Relation between linear and angular velocity, linear acceleration and angular acceleration (related numerical), Centripetal and Centrifugal forces with live examples, Expression and applications such as banking of roads and bending of cyclist.

Unit 3: Work, Power and Energy [09]

Work: Concept and units, examples of zero work, positive work and negative work Friction: concept, types, laws of limiting friction, coefficient of friction, reducing friction and its engineering applications, Work done in moving an object on horizontal and inclined plane for rough and plane surfaces and related applications.

Energy and its units, kinetic energy, gravitational potential energy with examples and derivations, mechanical energy, conservation of mechanical energy for freely falling bodies, transformation of energy (examples).

Power and its units, power and work relationship, calculation of power (numerical problems).

Unit 4: Rotational Motion [08]

Translational and rotational motions with examples, Definition of torque and angular momentum and their examples, Conservation of angular momentum (quantitative) and its applications.

Moment of inertia and its physical significance, radius of gyration for rigid body, Theorems of parallel and perpendicular axes (statements only), Moment of inertia of rod, disc, ring and sphere (hollow and solid); (Formulae only).

Unit 5: Properties of Matter [08]

Elasticity: definition of stress and strain, modulus of elasticity, Hooke's law, significance of stress-strain curve.

Pressure: definition, units, atmospheric pressure, gauge pressure, absolute pressure, Fortin's Barometer and its applications.

Surface tension: concept, units, cohesive and adhesive forces, angle of contact, Ascent Formula (No derivation), applications of surface tension, effect of temperature and impurity on surface tension.

Viscosity and coefficient of viscosity: Terminal velocity, Stokes law and effect of temperature on viscosity, application in hydraulic systems.

Hydrodynamics: Fluid motion, stream line and turbulent flow, Reynolds number Equation of continuity, Bernoulli's Theorem (only formula and numerical) and its applications.

Unit 6: Heat and Thermometry [06]

Concept of heat and temperature, modes of heat transfer (conduction, convection and radiation with examples), specific heats, scales of temperature and their relationship, Types of Thermometer (Mercury thermometer, Bimetallic thermometer, Platinum resistance thermometer, Pyrometer) and their uses.

Expansion of solids, liquids and gases, coefficient of linear, surface and cubical expansions and relation amongst them, Co-efficient of thermal conductivity, engineering applications.

Learning Outcome:

After undergoing this subject, the student will be able to:

- Identify physical quantities, select their units for use in engineering solutions, and make measurements with accuracy by minimizing different types of errors.
- Represent physical quantities as scalar and vectors and solve real life relevant problems.
- Analyse type of motions and apply the formulation to understand banking of roads/railway tracks and conservation of momentum principle to describe rocket propulsion, recoil of gun etc.
- Define scientific work, energy and power and their units. Derive relationships for work, energy and

power and solve related problems.

- Describe forms of friction and methods to minimize friction between different surfaces.
- State the principle of conservation of energy. Identify various forms of energy, and energy transformations.
- Compare and relate physical properties associated with linear motion and rotational motion and apply conservation of angular momentum principle to known problems.
- Describe the phenomenon of surface tension, effects of temperature on surface tension and solve statics problems that involve surface tension related forces.
- Describe the viscosity of liquids, coefficient of viscosity and the various factors affecting its value. Determine viscosity of an unknown fluid using Stokes' Law and the terminal velocity.
- Define stress and strain. State Hooke's law and elastic limits, stress–strain diagram, determine; (a) the modulus of elasticity, (b) the yield strength (c) the tensile strength, and (d) estimate the percent elongation.
- Illustrate the terms; heat and temperature, measure temperature in various processes on different scales (Celsius, Fahrenheit, and Kelvin etc.)
- Distinguish between conduction, convection and radiation; identify different methods for reducing heat losses and mode of heat transfer between bodies at differenttemperatures.
- State specific heats and measure the specific heat capacity of solids and liquids.

References:

1. Text Book of Physics for Class XI& XII (Part-I, Part-II); N.C.E.R.T., Delhi
2. Applied Physics, Vol. I and Vol. II, TTTI Publications, Tata McGraw Hill, Delhi.
3. Concepts in Physics by HC Verma, Vol. I & II, Bharti Bhawan Ltd. New Delhi
4. Engineering Physics by PV Naik, Pearson Education Pvt. Ltd, New Delhi
5. Engineering Physics by DK Bhhatacharya & PoonamTandan; Oxford University Press, New Delhi.
6. Comprehensive Practical Physics, Vol, I & II, JN Jaiswal, Laxmi Publications (P) Ltd., New Delhi
7. Practical Physics by C. L. Arora, S. Chand Publication.
8. e-books/e-tools/ learning physics software/websites etc.

APPLIED CHEMISTRY

Subject Code 2001103	Theory			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	02	01	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:

There are numerous number materials used in fabricating and manufacturing devices for the comfort of life. The selection, characterization and suitability assessment of natural raw materials essentially requires principles and concepts of Applied Chemistry for students. On successful completion of this course :-

- The students will be able to understand, ascertain and analyse the properties of natural raw materials required for producing economical and eco-friendly finished products.
- Solve various engineering problems applying the basic knowledge of atomic structure and chemical bonding.
- Use relevant water treatment method to solve domestic and industrial problems.
- Solve the engineering problems using knowledge of engineering materials and properties.
- Use relevant fuel and lubricants for domestic and Industrial applications
- Solve the engineering problems using concept of Electrochemistry and Corrosion.

Course Content :

UNIT-I Atomic Structure and Chemical Bonding.   [10]

Rutherford Model of Atom, Photoelectric Effect, Bohr's Theory (Expression of Energy and Radius to be omitted) and hydrogen spectrum explanation based on Bohr's Model of Atom, Wave Mechanical model of atom, de Broglie relationship, Heisenberg Uncertainty Principle, Quantum Number, Shapes of Atomic Orbitals, Pauli's Exclusion Principle, Hund's Rule of Maximum Multiplicity, Aufbau Principle, Electronic Configuration (till atomic number 30).

Concept of Chemical bonding – Cause of chemical bonding, Types of Bonds : Ionic Bond (NaCl, $CaCl_2$, MgO), Covalent Bond, Polar and Non polar Covalent Bonds (H_2, F_2, HF, HCl) & Co-ordinate Bond (CO, NH_4^+, O_3, H_2SO_4), Dipole Moment (NH_3, NF_3), Hydrogen bonding, Anamalous properties of NH_3, H_2O due to Hydrogen Bonding .

Concept of Hybridisation, Structure and Shape of Simple Inorganic Molecule e.g. $BeCl_2$, BF_3, CH_4, NH_3, H_2O on the basis of hybridisation.

UNIT-II Water   [08]

Introduction, Sources of Water, Hardness of Water, Degree of Hardness (In terms of $CaCO_3$ equivalent), Unit of Hardness, Quantitative Measurement of Water Hardness by EDTA method. Municipal supply of Water, Disinfection of Water.

Water Softening Technique-Soda Lime Process, Determination of Dissolved Oxygen, Water Quality Index – Biological Oxygen Demand, Chemical Oxygen Demand, Simple Numerical Problems.

UNIT-III Engineering Materials.   [08]

Natural Occurrence of Metals, Metallurgy – brief account of general principles of Metallurgy, Gangue, Flux and Slag, Extraction of Aluminum, Iron and Copper from their important ores along with

reactions.

Alloys – Definition, Purpose of Alloying, Ferrous and Non Ferrous Alloy with suitable examples, Composition, Properties and Applications.

Polymers–Homopolymers and Copolymers, Addition and Condensation Polymerization e.g. Polythene, Orlon, Terylene, Nylon 66, Nylon 6, Bakelite, Thermoplastic and Thermosetting plastic, Rubber and Vulcanization of Rubber with Chemical Reaction.

UNIT-IV <u>**Chemistry of Fuel and Lubricants.**</u>   **[09]**

Definition of Fuel, Characteristics of an Ideal Fuel, Classification of Fuel, Calorific Values (HCV and LCV), Determination of Calorific Value by using Bomb Calorimeter, Calculation of HCV and LCV using Dulong's formula.

Petrol and Diesel-Fuel Rating (Octane and Cetane Number), Chemical Composition, Calorific Values and Application of LPG, CNG and Biogas.

Lubricants-Functions and Properties of Good Lubricant, Viscosity & Viscosity Index, Flash point, Fire point, Cloud & Pour point, Classification of Lubricants with examples.

UNIT-V <u>**Electrochemistry.**</u>   **[10]**

Introduction, Electrolyte and Non electrolyte, Arrhenius Theory of Ionization, Electrolytic and Metallic Conduction, Factors affecting Electrolytic Conductance, Ohm's law, Molar Conductivity and Equivalent Conductivity, Variation of Molar Conductivity, Kohlrausch's law, Electrolysis, Faraday's Laws of Electrolysis and simple numerical problems.

Galvanic Cell, Electrode Potential, Measurement of Electrode Potential NHE (Normal Hydrogen electrode) EMF, Electrochemical Series, Nernst Equation for Electrode Potential.

Batteries, (Commercial Cells) - Primary cells-Dry cell, Secondary cell -Lead storage battery, Fuel cells.

Corrosion as an Electrochemical Process.

Learning Outcomes

At the end of the course student will be able to

1. Understand the classification and general properties of engineering materials such as metal, alloys, and composite materials using knowledge of chemical bonding.

2. Understand and assess the suitability of water source for domestic and industrial application, effluents and minimize water pollution.

3. Qualitatively analyze the engineering materials and understand their properties and applications.

4. Choose fuel and lubricants suitable for economical industrial processing to obtain eco-friendly finished products.

5. a) Ascertain construction, mechanism efficiency of electrochemical cells, solar cell fuel cells

   b) Understand corrosion and develop economical prevention techniques.

References/Suggested Learning Resources:

(a) Books :

1) Text Book of Chemistry for Class XI& XII (Part-I, Part-II); N.C.E.R.T., Delhi, 2017-18.

2) Agrawal, & Shikha, Engineering Chemistry, Cambridge University Press; New Delhi, 2015.

3) C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.

4) Dara, S. S. & Dr.S.S.Umare, Engineering Chemistry, S.Chand. Publication, New Delhi, 2015.

5) Jain & Jain, Engineering Chemistry, Dhanpat Rai and Sons; New Delhi, 2015.

6) Dr. Vairam, S., Engineering Chemistry, Wiley India Pvt.Ltd., New Delhi, 2013.

7) Dr. G. H. Hugar & Prof A. N. Pathak, Applied Chemistry Laboratory Practices, Vol. I and Vol. II, NITTTR, Chandigarh, Publications, 2013-14.

8) Agnihotri, Rajesh, Chemistry for Engineers, Wiley India Pvt.Ltd., 2014.

(b) Open source software and website address:

1   www.chemguide.co.uk/atommenu.html (Atomic structure and chemical bonding)

2   www.visionlearning.com (Atomic structure and chemical bonding)

3   www.chem1.com (Atomic structure and chemical bonding)

4   https://www.wastewaterelearning.com/elearning/ (Water Treatment)

5   www.capital-refractories.com (Metals, Alloys, Cement, and Refractory Materials)

6   www.em-ea.org/guide%20books/book-2/2.1%20fuels%20and%20combustion.pdf (Fuel and Combustion)

7   www.chemcollective.org (Metals, Alloys)

8   www.wqa.org(Water Treatment)

COMMUNICATION SKILLS IN ENGLISH

Subject Code 2001104	Theory			No of Periods in One Session : 30			Credits
	No. of Periods Per Week			Full Marks	:	100	02
	L	T	P/S	ESE	:	70 (50Eng.+20 Hindi)	
	02	-	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:

Communication skills play an important role in career development. This course aims at introducing basic concepts of communication skills with an emphasis on developing personality of the students. Thus, the main objectives of this course are:

To develop confidence in speaking English with correct pronunciation;

To develop communication skills of the students i.e. listening, speaking, reading and writing skills; and

To introduce the need for personality development.

Focus will be on developing certain qualities which will aid students in handling personal and career challenges, leadership skills etc.

Course Content :

Part - A (English)   F.M. - 50(English)

UNIT - 1   COMMUNICATION: THEORY AND PRACTICE   [04]

♦ **Basics of Communication:** Introduction, Meaning and Definition, Process of Communication, Elements of Communication: Sender-Message-Channel-Receiver-Feedback & Context, Feedback: Definition & Importance.

♦ **Types of Communication:** Formal and Informal, Verbal-Non-verbal, Types of Verbal Communication: Oral and Written, Non-Verbal Codes such as Kinesics, Proxemics, Haptics, Vocalics, Chronemics, Physical Appearance; Tables, Charts and Graphs in Graphic Communication Oral and Written.

UNIT - 2   EFFECTIVE COMMUNICATION AND COMMUNICATION BARRIERS   [04]

♦ **Concept, 7 Cs for Effective Communication (Considerate, Concrete, Concise, Clear, Complete, Correct, Courteous);**

♦ **Art of Effective Communication: Choosing Words, Voice, Modulation, Clarity, Time, Simplification of Words.**

♦ **Different Barriers to Communication, Ways to Remove/Minimize.**

UNIT - 3   READING COMPREHENSION   [03]

♦ **Comprehension and Vocabulary enhancement based on reading of the following texts:**
   SECTION-1

   Malgudi Days: **R.K. Narayan**

   What Students Can Do: **Mohandas Karamchand Gandhi**

   The Secret of Work :   **Swami Vivekanand**

SECTION-2

Stopping by Woods on a Snowy Evening:	Robert Frost
Where the Mind Is without Fear:	Rabindranath Tagore
Ode on Solitude:	Alexander Pope
A Psalm of Life:	H.W. Longfellow

UNIT - 4   FORMAL WRITTEN SKILLS/PROFESSIONAL WRITING   [04]

♦ **Application to Principal/Librarian.**

♦ **Drafting E-mails, Messages and Notices.**

♦ **Business Letters: Enquiry Letter, Order Letter, Complaint Letter, Adjustment Letter.**

♦ **Application / Official Letter Writing.**

♦ **Report Writing.**

UNIT - 5   VOCABULARY AND GRAMMAR   [05]

♦ **Vocabulary of Common Words.**

♦ **One Word Substitution, Common Idioms and Phrases.**

♦ **Use of Synonyms & Antonyms.**

♦ **Parts of Speech, Simple Sentence and Question, Adding Question-Tags, Removal of 'Too', Active Voice into Passive Voice, Direct Speech into Indirect Speech (in cases of Simple Sentence and Question), Punctuation.**

Part-B (Hindi)   *कुल-20 अंक (हिन्दी)*

UNIT - 1.   सम्प्रेषण - सिद्धांत एवां व्यवहार   [02]

सम्प्रेषण - परिचय, अर्थ एवं परिभाषा, सम्प्रेषण की प्रक्रिया

1. सम्प्रेषण के प्रकार - औपचारिक एवां अनौपचारिक, शब्दिक एवां अशब्दिक

2. प्रभावशाली सम्प्रेषण के सिद्धांत एवां व्यवधान

3. प्रभावशाली सम्प्रेषण कौशल - शदि चयन, आवधज़, स्वर   , स्वर सधमांजस्य, स्पष्टता, शदिों की पररवतन   सरलता

4. तकनीकी सम्प्रेषण

UNIT - 2.   . व्यधवसधयययक उत्कृष्टता हेतु व्यवहार कौशल   [02]

1. पररचय - तकनीकी कौशल एवां व्यवहार कौशल

2. व्यवहार कौशल कध महत्व

3. जीवन कौशल - आत्म जधगरूकता एवां आत्म ववश्लेषण

4. भधवनधत्मक बुद्धिमता एवां करुणध, अनुकूलनशीलता एवां लचीलधपन

5. व्यवहार कौशल कध उपयोग - वत्त अध्ययन

UNIT - 3. पठ बो् शदिधवली पररवदतन एवां व्यधकरण स [02]
अभ्यष

निरंित पाठय सामग्री - सू की रधत

(क) रेमचांि की कहधयनयां - शतरांज के खिलधड़ी, नमक कध
िधरोगध, इंगधध, प

(ि) रखवदरनधध टैगोर की रचनध-मन जहधां भय से मुकत हो

(ग) कबीर के पि एवां िोहे

UNIT - 4. **लेखि कोशल** [02]

1. सधर लेिन

2. औपचधररक पत्र लेिन - एवां व्यधवसधययक पत्र] *Ijdkjh i=] v)Zljdkjh i=&ys[ku*
कधसमक

3. रधरूप लेिन - सूचनध, बधयोडधटध *fufonk ys[ku] izfrosnu&ys[ku*

UNIT - 5. **शदिधवली एवां व्यधकरण** [02]

1. सधमधन्य शदिधवली

2. रशधसयनक शदिधवली

3. शदि भेि, अनेक शदिों के लिए एक शदि

4. ववरधम धचन्दह

5. मुहधवरेां एवां कहधवतेां

References:

1. J.D.O'Connor. *Better English Pronunciation.* Cambridge: Cambridge University Press, 1980.
2. Lindley Murray. *An English Grammar: Comprehending Principles and Rules.* London: Wilson and Sons, 1908.
3. Kulbhushan Kumar, Effective Communication Skills, Khanna Publishing House, New Delhi (Re- vised Edition 2018)
4. Margaret M. Maison. *Examine your English.* Orient Longman: New Delhi, 1964.
5. M. Ashraf Rizvi. *Effective Technical Communication*. Mc-Graw Hill: Delhi, 2002.
6. John Nielson. *Effective Communication Skills.* Xlibris, 2008.
7. *Oxford Dictionary*
8. *Roget's Thesaurus of English Words and Phrases*
9. *Collin's English Dictionary*

Course outcomes:
At the end of this course, the participants will:
- Develop basic speaking and writing skills including proper usage of language and vocabulary so that they can become highly confident and skilled speakers and writers.

- Be informed of the latest trends in basic verbal activities such as presentations, facing interviews and other forms of oral communication.

- Also develop skills of group presentation and communication in team.

- Develop non-verbal communication such as proper use of body language and gestures.

ENGG. GRAPHICS

Subject Code 2001105	Theory			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	100	
	L	T	P/S	ESE	:	70	02
	03	-	-	TA	:	10	
	-	-	-	CT	:	20	

Course Objectives:

- To understand the language of graphics which is used to express ideas, convey instructions while carrying out engineering jobs.
- To develop drafting and sketching skills, to know the applications of drawing equipments, and get familiarize with Indian Standards related to engineering drawings.
- To develop skills to visualize actual object or a part of it, on the basis of drawings.
- To develop skills to translate ideas into sketches and to draw and read various engineering curves, projections and dimensioning styles.
- To understand the basic commands and develop basic skills related to computer aided drafting, of how to draw, modify, and edit basic shapes (2D), using AUTOCAD.

Course Content

UNIT – I   Basic elements of Drawing   [06]

Drawing Instruments and supporting materials: method to use them with applications. Convention of lines and their applications.

Representative Fractions – reduced, enlarged and full size scales; Engineering Scales such as plain and diagonal scale.

Dimensioning techniques as per SP-46:2003 – types and applications of chain, parallel and coordinate dimensioning.

Geometrical and Tangency constructions. (Redraw the figure)

UNIT – II   Orthographic projections   [08]

Introduction of projections-orthographic, perspective, isometric and oblique: concept and applications.

Introduction to orthographic projection, First angle and Third angle method, their symbols.

Conversion of pictorial view into Orthographic Views – object containing plain surfaces, slanting surfaces, slots, ribs, cylindrical surfaces. (use First Angle Projection method only)

UNIT – III   Isometric Projections   [08]

Introduction to isometric projections.

Isometric scale and Natural scale.

Isometric view and isometric projection.

Illustrative problems related to objects containing lines, circles and arcs shape only. Conversion of orthographic views into isometric view/projection.

UNIT – IV   Free Hand Sketches of engineering elements   [07]

Free hand sketches of machine elements: Thread profiles, nuts, bolts, studs, set screws, washer, Locking arrangements. (For branches other than mechanical Engineering, the teacher should select branch specific elements for free hand sketching) Free hand sketches of orthographic view (on squared graph paper) and isometric view (on isometric grid paper)

UNIT – V Computer aided drafting interface   [08]

Computer Aided Drafting: concept. Hardware and various CAD software available.

System requirements and Understanding the interface.

Components of AutoCAD software window: Title bar, standard tool bar, menu bar, object properties tool bar, draw tool bar, modify tool bar, cursor cross hair. Command window, sta- tus bar, drawing area, UCS icon.

File features: New file, Saving the file, Opening an existing drawing file, Creating templates, Quit.

Setting up new drawing: Units, Limits, Grid, Snap.

Undoing and redoing action.

UNIT – VI Computer aided drafting   [08]
Draw basic entities like Line, Circle, Arc, Polygon, Ellipse, Rectangle, Multiline, PolyLine.

Method of Specifying points: Absolute coordinates, Relative Cartesian and Polar coordinates.

Modify and edit commands like trim, extend, delete, copy, offset, array, block, layers.

Dimensioning: Linear, Horizontal Vertical, Aligned, Rotated, Baseline, Continuous, Diameter, Radius, Angular Dimensions.

Dim scale variable.
Editing dimensions.
Text: Single line Text, Multiline text.
Standard sizes of sheet. Selecting Various plotting parameters such as Paper size, paper units, Drawing orientation, plot scale, plot offset, plot area, print preview.

S. No.	Exercises	Unit No.
1	Draw horizontal, Vertical, 30 degree, 45 degree, 60 and 75 degrees lines, different types of lines, dimensioning styles using Tee and Set squares/ drafter. (do this exercise in sketch book)	I
2	Write alphabets and numerical (Vertical only) (do this exercise in sketch book)	I
3	Draw regular geometric constructions and redraw the given figure (do this exercise in sketch book) Part I	II
4	Draw regular geometric construction and redraw the given figure (do this exercise in sketch book) Part II	II
5	Draw a problem on orthographic projections using first angle method of projection having plain surfaces and slanting. Part I	III
6	Draw another problem on orthographic projections using first angle method of projection having slanting surfaces with slots. Part II	III
7	Draw two problems on orthographic projections using first angle method of projection having cylindrical surfaces, ribs. Part I	III
8	Draw two problems on Isometric view of simple objects having plain and slanting surface by using natural scale. Part I	IV
9	Draw some problems on Isometric projection of simple objects having cylindrical surface by using isometric scale. Part I	IV

10	Draw free hand sketches/ conventional representation of machine elements `in sketch book such as thread profiles, nuts, bolts, studs, set screws, washers, Locking arrangements. Part I	V
11	Problem based Learning: Given the orthographic views of at least three objects with few missing lines, the student will try to imagine the corresponding objects, complete the views and draw these views in sketch book. Part I	III, II, V
12	Draw basic 2D entities like: Rectangle, Rhombus, Polygon using AutoCAD (Print out should be a part of progressive assessment). Part I	V
13	Draw basic 2D entities like: Circles, Arcs, circular using AutoCAD (Printout should be a part of progressive assessment). Part II	V
14	Draw basic 2D entities like: Circular and rectangular array using AutoCAD (Printout should be a part of progressive assessment). Part III	V
15	Draw blocks of 2D entities comprises of Rectangle, Rhombus, Polygon, Circles, Arcs, circular and rectangular array, blocks using AutoCAD (Print out should be a part of progressive assessment). Part IV	V
16	Draw basic branch specific components in 2D using AutoCAD (Print out should be a part of term work). Part I	VI
17	Draw complex branch specific components in 2D using AutoCAD (Print should be a part of progressive assessment). Part I	VI
	Total	

SUGGESTED LEARNING RESOURCES

1. Bureau of Indian Standards. *Engineering Drawing Practice for Schools and Colleges IS: Sp-46.* BIS. Government of India, Third Reprint, October 1998; ISBN: 81-7061-091-2.

2. Bhatt, N. D. *Engineering Drawing*. Charotar Publishing House, Anand, Gujrat 2010; ISBN: 978-93- 80358-17-8.

3. Jain & Gautam, Engineering Graphics & Design, Khanna Publishing House, New Delhi (ISBN: 978- 93-86173-478)

4. Jolhe, D. A. *Engineering Drawing*. Tata McGraw Hill Edu. New Delhi, 2010; ISBN: 978-0-07- 064837-1

5. Dhawan, R. K. *Engineering Drawing*. S. Chand and Company, New Delhi; ISBN: 81-219-1431-0.

6. Shah, P. J. *Engineering Drawing*. S. Chand and Company, New Delhi, 2008, ISBN:81-219-2964-4.

7. Kulkarni, D. M.; Rastogi, A. P.; Sarkar, A. K. *Engineering Graphics with AutoCAD*. PHI Learning Pri- vate Limited-New Delhi (2010); ISBN: 978-8120337831.

8. Jeyapoovan, T. *Essentials of Engineering Drawing and Graphics using AutoCAD*. Vikas Publishing HousePvt. Ltd, Noida, 2011; ISBN: 978-8125953005.

9. Autodesk. *AutoCAD User Guide*. Autodesk Press, USA, 2015.

10. Sham, Tickoo. *AutoCAD 2016 for Engineers and Designers*. Dreamtech Press; Galgotia Publication, New Delhi, 2015; ISBN 978-9351199113.

Software/Learning Websites

1. https://www.youtube.com/watch?v=TJ4jGyD-WCw

2. https://www.youtube.com/watch?v=dmt6_n7Sgcg

3. https://www.youtube.com/watch?v=_MQScnLXL0M

4. https://www.youtube.com/watch?v=3WXPanCq9LI

5. https://www.youtube.com/watch?v=fvjk7PlxAuo

6. http://www.me.umn.edu/coursesme2011/handouts/engg%20graphics.pdf

7. https://www.machinedesignonline.com

Course Outcomes

Following outcomes will be achieved:

1) Select and construct appropriate drawing scales, use drawing equipment's, and understand Indian Standards of engineering drawing

2) Draw views of given object and components 3) Sketch orthographic projections into isometric projections and vice versa.

3) Apply computer aided drafting tools to create 2D engineering drawings

APPLIED PHYSICS LAB-I

Subject Code 2001106	Practical			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal(PA)	:	15	
		-	03	External(ESE)	:	35	

Course Objectives

Study of Applied Physics aims to give an understanding of physical world by observations and predictions. Concrete use of physical principles and analysis in various fields of engineering and technology is very prominence. The course aims to supplement the factual knowledge gained in the lecture by first hand manipulation of apparatus. This will develop scientific temper and help to apply the basic concepts and principles in solving engineering and technology based problems. In addition, students get necessary confidence in handling equipment and thus learn various skills inmeasurement.

List of Practical's (To perform minimum 10 practical's).

1. To measure length, radius of a given cylinder, a test tube and a beaker using a Vernier caliper and find volume of each object.
2. To determine diameter of a wire, a solid ball and thickness of cardboard using a screw gauge.
3. To determine radius of curvature of a convex and a concave mirror/surface using a spherometer.
4. To verify triangle and parallelogram law of forces.
5. To find the co-efficient of friction between wood and glass using a horizontal board.
6. To determine force constant of a spring using Hook's Law.
7. To verify law of conservation of mechanical energy (PE to KE).
8. To find the moment of inertia of a flywheel.
9. To find the viscosity of a given liquid (Glycerin) by Stokes law.
10. To find the coefficient of linear expansion of the material of a rod.
11. To determine atmospheric pressure at a place using Fortin's barometer.
12. To measure room temperature and temperature of a hot bath using mercury thermometer and convert it into different scales.

Learning Outcome:

After undergoing this lab work, the student will be able to:

- Select right kind of measuring tools (Meter scale, Vernier caliper, Screw gauge, Spherometer etc.) for determining dimensions of physical quantities and make measurements with accuracy and precision.

- Differentiate various shapes and determine dimensions of plane, curved and regular surfaces/bodies.

- Apply and Verify laws of forces and determine resultant force acting on a body.

- Appreciate role of friction and measure co-efficient of friction between different surfaces.

- Describe and verify Hook's law and determine force constant of spring body.

- Identify various forms of energy, energy transformations and verify law of conservation of energy.

- Understand rotational motion and determine M.I. of a rotating body (flywheel)

- Understand Stokes law for viscous liquids and determine viscosity of a given liquid.

- Understand how materials expand on heating and determine linear expansion coefficient for

a given material rod. Understand working and use Fortin's barometers for determining pressure at a place.

- Understand use of thermometers to measure temperature under different conditions and different scales of temperature measurements.

SUGGESTED STUDENT ACTIVITES & STRATEGIES

Apart from classroom and laboratory learning following are the suggested student related activities which can be undertaken to accelerate the attainment of various outcomes of the course

a. Make survey of different physical products and compare the following points
   - Measurements of dimensions
   - Properties
   - Applications
b. Library survey regarding engineering materials/products used in different industries
c. Seminar on any relevant topic.

Teachers should use the following strategies to achieve the various outcomes of the course.

- Different methods of teaching and media to be used to attain classroom attention.

- Massive open online courses (MOOCs) may be used to teach various topics/sub topics.

- 15-20% of the topics which are relatively simpler of descriptive in nature should be given to the students for self-learning and assess the development of competency through classroom presentations.

- Micro-projects may be given to group of students for hand-on experiences.

References:

1. Text Book of Physics for Class XI& XII (Part-I, Part-II); N.C.E.R.T., Delhi

2. Comprehensive Practical Physics, Vol, I & II, JN Jaiswal, Laxmi Publications (P)Ltd.,

3. Practical Physics by C. L. Arora, S. Chand Publication.

4. e-books/e-tools/ learning physics software/YouTube videos/websites etc.

APPLIED CHEMISTRY LAB

Subject Code 2001107	Practical			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	50	
	L	T	P/S	Internal(PA)	:	15	02
		-	03	External(ESE)	:	35	

Course Objectives:

There are numerous number of materials used in fabricating and manufacturing devices for the comfort of life. The selection, characterization and suitability assessment of natural raw materials essentially requires principles and concepts of Applied Chemistry for students. The course aims to supplement the factual knowledge gained in the lectures by first hand manipulation of processes and apparatus. This will develop scientific temper and help to apply the basic concepts and principles in solving technology based problems. In addition, students will get necessary confidence in handling equipments and thus learn various skills in measurement.

List of Practicals : Perform any 12 (twelve) Practicals :-

1. Preparation of 250ml N/10 Oxalic acid Solution.

2. Preparation of 250ml N/10 Sodium Carbonate Solution.

3. To determine the strength of Sodium Hydroxide Solution by Titrating against Oxalic Acid Solution.

4. Determination of Temporary Hardness of Tap Water.

5. Gravimetric Estimation of Moisture in given Coal Sample.

6. Determination of Percentage of Water of Crystallization in Barium Chloride.

7. Preparation of Cupric Oxide from Copper Sulphate.

8. Preparation of Barium Sulphate from Barium Chloride.

9-11. Qualitative Analysis of Three Solutions containing One Basic and One Acid radicals Listed below.

   Basic radicals – NH_4^+, Pb^{+2}, Cu^{+2}, Ni^{+2}, Zn^{+2}, Fe^{+2}.

   Acid radicals – Cl^-, Br^-, I^-, NO_3^-, CO_3^{-2}, SO_4^{-2}.

12. Determination of Viscosity of Lubricating Oil Using Ostwald Viscometer.

13. To Verify Faradays First Law of Electrolysis.

14. To determine pH of given solution by pH meter.

15. Prepare Phenol Formaldehyde Resin (Bakelite)

16. To Determine Dissolved Oxygen in given Sample of Water.

Learning Outcomes:

At the end of the course student will be able to

- To express quantitative measurements accurately.

- To practice and adapt good measuring techniques.

- To use various apparatus for precise measurements.

- To understand and differentiate different methods of quantitative analysis.

- To know and understand principles of quantitative analysis using instruments.

- To construct different electrochemical cells used in developing batteries.

- To understand and appreciate methods of corrosion abetments.

Reference Books:

1. Text Book of Chemistry for Class XI & XII (Part-I, Part-II); N.C.E.R.T., Delhi, 2017-18.

2. Dr. G. H. Hugar and Prof A. N. Pathak, Applied Chemistry Laboratory Practices, Vol. I and Vol. II, NITTTR, Chandigarh, Publications, 2013-14.

3. Agnihotri, Rajesh, Chemistry for Engineers, Wiley India Pvt.Ltd., 2014.

4. Jain & Jain, Engineering Chemistry, Dhanpat Rai and Sons; New Delhi, 2015.

COMMUNICATION SKILLS IN ENGLISH LAB

Subject Code 2001108	Practical			No of Periods in One Session : 45			Credits
	No. of Periods Per Week			Full Marks	:	50	
	L	T	P/S	Internal(PA)	:	15	02
		-	03	External(ESE)	:	35	

Course Objectives:

Communication skills play an important role in career development. This lab course aims at actively involving students in various activities to improve their communication skills with an emphasis on developing personality of the students. Thus, the objectives of this course are:

1. To develop listening skills for enhancing communication.

2. To develop speaking skills with a focus on correct pronunciation and fluency.

3. To introduce the need for Personality development- Focus will be on developing certain qualities which will help students in handling personal and career challenges, leadership skills etc. For that purpose group discussion, extempore and other activities should be conducted during lab classes.

Course Content:

UNIT- 1 Listening Skills

Listening Process and Practice: Introduction to recorded lectures, poems, interviews and speeches, listening tests.

UNIT- II   Introduction to Phonetics

Sounds: consonant, vowel, diphthongs, etc. transcription of words (IPA), weak forms, syllable division, word stress, intonation, voice etc.

UNIT- III Speaking Skills

Standard and formal speech: Group discussion, oral presentations, public speaking, extempore speech, business presentations conversation practice and role playing, mock interviews etc.

UNIT- IV Building Vocabulary

Etymological study of words and construction of words, phrasal verbs, idioms and phrases.

Jargon/ Register related to organizational set up, word exercises and word games to enhance self-expression and vocabulary of participants.

Recommended Readings:

1. Daniel Jones. *The Pronunciation of English.* Cambridge: Cambridge University Press, 1956.

2. James Hartman& et al. Ed. *English Pronouncing Dictionary.* Cambridge: Cambridge University Press 2006.

3. Kulbhushan Kumar, Effective Communication Skills, Khanna Publishing House, New Delhi (Revised Ed. 2018)

4. J.D.O'Connor. *Better English Pronunciation.* Cambridge: Cambridge University Press, 1980.

5. Lindley Murray. *An English Grammar: Comprehending Principles and Rules.* London: Wilson and Sons, 1908.

6. Margaret M. Maison. *Examine your English.* Orient Longman: New Delhi, 1964.

7. J.Sethi & et al. *A Practice Course in English Pronunciation*. New Delhi: Prentice Hall, 2004.

8. Pfeiffer, William Sanborn and T.V.S Padmaja. *Technical Communication: A Practical Approach*. 6th ed. Delhi: Pearson, 2007.

Learning Outcome:

- At the end of this course the students will be able to communicate effectively with an increase in their confidence to read, write and speak English fluently.

- They will also demonstrate a significant increase in word power.

- The variety of exercises and activities that will be conducted in the Language Lab will devel- op their skills needed to participate in a conversation like listening carefully and respectfully to others' viewpoints; articulating their own ideas and questions clearly and over all students will be able to prepare, organize, and deliver an engaging oral presentation.

- They will also develop non-verbal communication such as proper use of body language and gestures.

ENGINEERING WORKSHOP PRACTICE

Subject Code 2001109	Term Work			No of Periods in One Session : 90			Credits
	No. of Periods Per Week			Full Marks	:	25	
	L	T	P/S	Internal(PA)	:	07	02
		-	06	External(ESE)	:	18	

Course Objectives:

- To understand basic engineering processes for manufacturing and assembly.

- To understand, identify, select and use various marking, measuring, and holding, striking and cutting tools and equipment's

- To understand and interpret job drawings, produce jobs, and inspect the job for specified dimensions

- To understand the various types of wiring systems and acquire skills in house wiring

- To understand, operate, control different machines and equipment's adopting safety practices Course Content:

Course Content :

I   **Carpentry:** i) Demonstration of different wood working tools / machines.   **[16]**

ii) Demonstration of different wood working processes, like plaining, marking, chiseling, grooving, turning of wood etc. iii) One simple job involving any one joint like mortise and tenon dovetail, bridle, half lap etc.

II   **Fitting:** i) Demonstration of different fitting tools and drilling machines and power tools   **[16]**

ii) Demonstration of different operations like chipping, filing, drilling, tapping, sawing, cutting etc.

iii) One simple fitting job involving practice of chipping, filing, drilling, tapping, cutting etc

III   **Welding:** i) Demonstration of different welding tools / machines. ii) Demonstration on Arc   **[16]**

15]Welding, Gas Welding, MIG, MAG welding, gas cutting and rebuilding of broken parts with welding. iii) One simple job involving butt and lap joint

IV   **Sheet Metal Working:** i) Demonstration of different sheet metal tools / machines.   **[16]**

ii) Demonstration of different sheet metal operations like sheet cutting, bending, edging, end curling, lancing, soldering, brazing, and riveting. iii) One simple job involving sheet metal operations and soldering and riveting.

V   **Electrical House Wiring:** Practice on simple lamp circuits (i) one lamp controlled by one   **[16]**

switch by surface conduit wiring, (ii) Lamp circuits- connection of lamp and socket by separate switches, (iii) Connection of Fluorescent lamp/tube light, (iv) simple lamp circuits-in- stall bedroom lighting. And (v) Simple lamp circuits- install stair case wiring.

VI   **Demonstration:** i) Demonstration of measurement of Current, Voltage, Power and Energy.   **[10]**

ii) Demonstration of advance power tools, pneumatic tools, electrical wiring tools and accessories. iii) Tools for Cutting and drilling

References:

1. S.K. Hajara Chaudhary, Workshop Technology, Media Promoters and Publishers, New Delhi, 2015
2. B.S. Raghuwanshi, Workshop Technology, Dhanpat Rai and sons, New Delhi 2014
3. K. Venkat Reddy, Workshop Practice Manual, BS Publications, Hyderabad 2014
4. Kents Mechanical Engineering Hand book, John Wiley and Sons, New York Course outcomes

At the end of the course, the student will be able to:

CO1   Acquire skills in basic engineering practice to identify, select and use various marking, measuring, and holding, striking and cutting tools & equipment's and machines

CO2   Understand job drawing and complete jobs as per specifications in allotted time

CO3   Inspect the job for the desired dimensions and shape

CO4   Operate, control different machines and equipment's adopting safety practices

SPORTS AND YOGA

Subject Code 2001110	Term Work			No of Periods in One Session : 30			Credits
	No. of Periods Per Week			Full Marks	:	25	02
	L	T	P/S	Internal(PA)	:	07	
		-	02	External(ESE)	:	18	

Course Objectives:

- To make the students understand the importance of sound health and fitness principles as they relate to better health.

- To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.

- To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.

- To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.

Course Content:

- **Introduction to Sports**

    o Meaning & Definition of Sports

    o Aims & Objectives of Physical Education

    o Awards and Honours in the Field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanchand Award, Rajiv Gandhi Khel Ratna Award etc.)

- **Physical Fitness, Wellness & Lifestyle**

    o Meaning & Importance of Physical Fitness & Wellness

    o Components of Physical Fitness

    o Components of Wellness

    o Preventing Health Threats through Lifestyle Change

    o Concept of Positive Lifestyle

- **Postures**

    o Meaning and Concept of Postures.

    o Causes of Bad Posture.

    o Concept & Advantages of Correct Posture.

- **Yoga**

    o Meaning & Importance of Yoga

    o Elements of Yoga

    o Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas

    o Yoga for Concentration & Related Asanas (Sukhasana; Tadasana; Padmasana & Sha-shankasana)

- **Yoga & Lifestyle**

  o Asanas as Preventive Measures.

  o Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana, Bhujangasana, Sharasana.

  o Obesity: Procedure, Benefits & Contraindications for Vajrasana.

  o Back Pain: Tadasana, Ardh Matsyendrasana, Bhujangasana.

  o Diabetes: Procedure, Benefits & Contraindications for Bhujangasana, Paschimottasana, Ardh Matsyendrasana.

  o Asthma: Procedure, Benefits & Contraindications for Sukhasana, Bhujangasana , Matsyasana.

- **Psychology & Sports**

  o Psychological Benefits of Exercise.

  o Anxiety & Fear and Its Effects on Sports Performance.

  o Motivation, Its types & Techniques.

  o Understanding Stress & Coping Strategies.

  - **Sports / Games**

  Following sub topics related to any one Game/Sport of choice of student out of: Athletics, Badminton, Chess, Cricket, Kabaddi, Table Tennis, Volleyball, Yoga etc.

    o History of the Games/Sport.

    o Latest General Rules of the Games/Sports.

    o Specifications of Play Fields and Related Sports Equipment.

    o Important Tournaments and Venues.

    o Sports Personalities.

References:

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light On Yoga By B.K.S. Iyengar.
3. Health and Physical Education – NCERT (11th and 12th Classes)

Course Outcomes:

On successful completion of the course the students will be able to:

(i) Practice Physical activities and Hatha Yoga focusing on Yoga for strength, flexibility, and relaxation.

(ii) Learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.

(iii) Learn breathing exercises and healthy fitness activities

(iv) Understand basic skills associated with yoga and physical activities including strength and flexibility, balance and coordination.

(v)   Perform Yoga movements in various combination and forms.

(vi)   Assess current personal fitness levels.

(vii)   Identify opportunities for participation in Yoga and Sports activities.

(viii) Develop understanding of health-related fitness components: cardiorespiratory endurance, flexibility and body composition etc.

(ix)   Improve personal fitness through participation in Sports and Yogic activities.

(x)   Develop understanding of psychological problems associated with the age and lifestyle.

(xi)   Demonstrate an understanding of sound nutritional practices as related to health and physical performance.

(xi)   Assess Yoga activities in terms of fitness value.

(xii)   Identify and apply injury prevention principles related to Yoga and physical fitness activities.

(xiv)   Understand and correctly apply biomechanical and physiological principles related to exercise and training.

C / KYP / IT ESSENTIAL / PYTHON / OTHERS

Subject Code 2001111	Term Work			No of Periods in One Session : 30			Credits
	No. of Periods Per Week			Full Marks	:	50	
	L	T	P/S	Internal(PA)	:	15	01
		-	02	External(ESE)	:	35	

STATE BOARD OF TECHNICAL EDUCATION, BIHAR

Scheme of Teaching and Examinations for
IIIrd SEMESTER DIPLOMA IN CIVIL ENGINEERING / CIVIL (RURAL) ENGINEERING
(Effective from Session 2020-21 Batch)

THEORY

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME							
			Periods per Week	Hours of Exam.	Teacher's Assessment (TA) Marks A	Class Test (CT) Marks B	End Semester Exam. (ESE) Marks C	Total Marks (A+B+C)	Pass Marks ESE	Pass Marks in the Subject	Credits
1.	Building Construction and Construction Materials	2015301	05	03	10	20	70	100	28	40	05
2.	Basic Surveying	2015302	04	03	10	20	70	100	28	40	03
3.	Mechanics of Materials	2015303	04	03	10	20	70	100	28	40	03
4.	Concrete Technology	2015304	03	03	10	20	70	100	28	40	03
5.	Geo Technical Engineering	2015305	03	03	10	20	70	100	28	40	03
		Total :-	19				350	500			17

PRACTICAL

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME				
			Periods per Week	Hours of Exam.	Practical		Total Marks	Pass Marks in the Subject	Credits
					Internal (PA)	External (ESE)			
6.	Basic Surveying Lab	2015306	02 50% Physical 50% Virtual	04	15	35	50	20	01
7.	Building Construction and Construction materials Lab	2015307	02 50% Physical 50% Virtual	04	15	35	50	20	01
8.	Web Technology Lab	2018308	02 50% Physical 50% Virtual	03	07	18	25	10	01
		Total :-	06				125		03

TERM WORK

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME				
			Periods per Week	Marks of Internal (PA)	Marks of External (ESE)	Total Marks	Pass Marks in the Subject	Credits
9.	Mechanics of Materials Lab (TW)	2015309	02	07	18	25	10	01
10.	Concrete Technology Lab (TW)	2015310	02	07	18	25	10	01
11.	Python	2018311	02	07	18	25	10	01
12.	Geo Technical Eng. Lab (TW)	2015312	02	15	35	50	20	01
		Total :-	08			125		04

| Total Periods per week Each of duration One Hour | 33 | | Total Marks = | 750 | | 24 |

Building Construction and Construction Materials

	Theory						Credits
Subject Code **2015301**	No. of Periods Per Week			Full Marks	:	100	05
	L	T	P/S	ESE	:	70	
	05	—		TA	:	10	
	—	—	—	CT	:	20	

Course Objective:

1. To identify different components of building.
2. To understand different types of foundation and their significance.
3. To know different types of masonry and their construction.
4. To highlight the importance of communications in building planning.
5. To learn about various construction materials.
6. To be able to identify suitability of various materials for different construction purposes.

COURSE OUTCOMES (COs):

1. Identify relevant construction materials.
2. Identify relevant natural construction materials.
3. Select relevant special type of construction materials.
4. Identify components of building structures.
5. Propose suitable type of foundation for building structures.
6. Select suitable type of masonry for building structures.
7. Propose relevant means of communications for different types of buildings.

Contents: Theory		Hrs
Unit -1	**Overview of Building Components** 1.1 Classification of Buildings as per National Building Code Group A to I, as per Types of Constructions- Load Bearing Structure, Framed Structure, Composite Structure. 1.2 Building Components - Functions of Building Components, Foundation, Plinth and Super structure.	08
Unit -2	**Natural And Artificial Construction Materials** 2.1 Requirements of good building stone; general characteristics of stone; quarrying and dressing methods and tools for stone. 2.2 Structure of timber, general properties and uses of good timber, different methods of seasoning for preservation of timber, defects in timber. 2.3 Asphalt, bitumen and tar used in construction, properties and uses. 2.4 Properties of sand and uses. 2.5 Classification of coarse aggregate according to size. 2.6 Constituents of brick earth, Conventional / Traditional bricks, Modular and Standard bricks, Special bricks –fly ash bricks, 2.7 Characteristics of good brick	12

Unit – 3	**Special and Processed Construction Materials**	
	3.1 Types of material and suitability in construction works of following materials: Water proofing, Termite proofing; Thermal and sound insulating materials. 3.2 Paints- whitewash, cement paint, Distempers, Oil Paints and Varnishes.	04
Unit – 4	**Construction of Substructure and Superstructure**	
	4.1 Job Layout: Site Clearance, Layout for Load Bearing Structure and Framed Structure by Center Line and Face Line Method, Precautions. **4.2.** Foundation: Functions of foundation, Types of foundation – Shallow Foundation, Stepped Footing, Wall Footing, Column Footing, Isolated and Combined Column Footing, Raft Foundation. **4.3. Stone Masonry:** Terms used in stone masonry- facing, backing, hearting, through stone, corner stone, cornice. Types of stone masonry: Rubble masonry, Ashlar Masonry and their types. **4.4. Brick masonry:** Terms used in brick masonry, header, stretcher, closer, quoins, course, face, back, hearting, bat bond, joints, lap, frog. Bonds in brick masonry- header bond, stretcher bond, English bond and Flemish bond. **4.5. Scaffolding and Shoring:** Purpose, Types of Scaffolding, Process of Erection and Dismantling. Purpose and Types of Shoring, Underpinning.	10
Unit-5	**5.1 Building Communication and Ventilation** Doors –Components of Doors, Full Paneled Doors, Partly Paneled and Glazed Doors, Flush Doors, Collapsible Doors, Rolling Shutters, Revolving Doors, Glazed Doors. Sizes of Door recommended by BIS. **5.2 Windows:** Component of windows, Types of Windows - Full Paneled, Partly Paneled and Glazed, wooden, Steel, Aluminum windows, Sliding Windows, Louvered Window, Bay window, Sizes of Windows recommended by BIS. Ventilators. **5.3 Vertical Communication:** Means of Vertical Communication- Stair Case, Ramps, Lift, Elevators and Escalators. Terms used in staircase-steps, tread, riser, nosing, soffit, waist slab, balustrade, scotia, hand rails, newel post, landing, headroom, winder. Types of staircases (On the basis of shape): Straight, dog-legged, open well, Spiral, quarter turn, bifurcated, three quarter turn and Half turn, **5.4 Wall Finishes:** Plastering – Necessity of Plastering, Procedure of Plastering, Single Coat Plaster, Double Coat Plaster, Rough finish. Precautions to be taken in plastering, defects in plastering. Pointing – Necessity, Types of pointing and procedure of Pointing, Painting. .	**14**
	Total	48

Suggested Text Book:

1) Ghose, D. N., Construction Materials, Tata McGraw Hill, New Delhi.

2) S.K. Sharma, Civil Engineering Construction Materials, Khanna Publishing House, Delhi

3) Varghese, P.C., Building Materials, PHI learning, New Delhi.

4) Rang Wala, S.C., Engineering Materials, Charoter publishing, House, Anand.

5) Somayaji, Shan, Civil Engineering Materials, Pearson education, New Delhi.

6) Rajput, R.K, Engineering Materials, S. Chand and Co., New Delhi.

7) Sood H., Laboratory Manual on Testing of Engineering Materials, New Age Publishers, New Delhi.

8) Sharma C. P., Engineering Materials, PHI Learning, New Delhi.

9) Duggal, S. K, Building Materials, New International, New Delhi

10) S. P. Arora and Bindra., Building Construction, Dhanpat Rai Publication, Delhi.

11) Sushil Kumar., Building Construction, Standard Publication.

12) Ranga Wala, S. C., Building Construction, publishing, House, Anand.

13) Punmia B. C., and Jain A. K., Building Construction.

14) Sharma S. K., Building Construction, S. Chand and Co. Pvt. Ltd., New Delhi.

15) Janardan Jha, Building Construction, Khanna Publication.

16	Building Construction	SNP Srivastava	FPH
17	Adhunik Bhawan Nirman	SNP Srivastava	FPH
18	Building Construction and Construction Materials	SNP Srivastava	FPH

BASIC SURVEYING

Subject Code 2015302	Theory						Credits 03
	No. of Periods Per Week			Full Marks	:	100	
	L	T	P/S	ESE	:	70	
	04	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objective:

1. To understand types of surveying works required.

2. To know the types of method and equipment's to be used for different surveys.

3. To know the use and operational details of various surveying equipment's**.**

COURSE OUTCOMES (COs):

1. Select the type of survey required for given situation.

2. Compute area of open field using chain, tape and cross staff.

3. Conduct traversing in the field using chain and compass.

4. Use levelling instruments to determine reduced level for preparation of contour maps

5. Use digital planimeter to calculate the areas

Contents: Theory		Hrs
Unit -1	**Overview and classification of survey**	04
	1.1 Survey- Purpose and Use.	
	1.2 Types of surveying- Primary and Secondary, Classification: Plane, Geodetic, Cadastral, Hydrographic and Aerial.	
	1.3 Principles of Surveying	
	1.4 Scales: Engineer's scale, Representative Fraction (RF) and diagonal scale.	
Unit -2	**Chain survey**	12
	2.1 Instruments used in chain survey: Metric Chain, Tapes, Arrow, ranging rod, Line ranger, Offset rod, Open cross staff, Optical square.	
	2.2 Chain survey Station, Baseline, Check line, Tie line, Offset, Tie station.	
	2.3 Ranging- Direct and Indirect Ranging, Methods of Chaining, obstacles in chaining.	
	2.4 Errors in length: Instrumental error, personal error, error due to natural cause, random error, Principles of triangulation.	
	2.5 Types of offsets: Perpendicular and Oblique, Conventional Signs, Recording of measurements in a field book.	

Unit – 3	**Compass traverse survey**	
	3.1 Compass Traversing-open, closed.	
	3.2 Technical Terms: Geographic/True, Magnetic Meridians and Bearings, Whole Circle Bearing system and Reduced Bearing system and examples on conversion of given bearing to another bearing (from one form to another), Fore Bearing and Back Bearing, Calculation of internal and external angles from bearings at a station, Dip of Magnetic needle, MagneticDeclination.	12
	3.3 Components of Prismatic Compass and their Functions, Methods of using Prismatic Compass- Temporary adjustments and observing bearings.	
	3.4 Local attraction, Methods of correction of observed bearings - Correction at station and correction to included angles	
	3.5 Methods of plotting a traverse and closing error, Graphical adjustment of closing error.	
Unit – 4	**Levelling and contouring**	
	4.1 Basic terminologies: Level surfaces, Horizontal and vertical surfaces, Datum, Bench Marks, Permanent, Arbitrary and Temporary, Reduced Level, Rise, Fall, Line of collimation, Station, Back sight, Fore sight, Intermediate sight, Change point, Height of instruments.	
	4.2 Types of levels: Dumpy, Tilting and Auto level,Temporary adjustments of Level.	
	4.3 Types of Levelling Staff: Self-reading staff and Target staff, Reduction oflevel by Height of Instrument Method and Rise and Fall Method.	
	4.4 Levelling Types: Simple, Differential, Fly, Profileand Reciprocal Levelling.	16
	4.5 Contour, contour intervals, horizontal equivalent, Uses of contour maps, Characteristics of contours, Methods of Contouring- Direct and indirect.	
Unit – 5	**Measurement of Area and Volume**	
	5.1 Components and use of Digital planimeter.	
	5.2 Measurement of area using digital planimeter.	
	5.3 Measurement of volume of reservoir from contourmap.	04
	TOTAL-	**48**

Suggested Text Book/ **Reference Book:**

1. Punmia, B.C; Jain, Ashok Kumar; Jain, Arun Kumar, Surveying I, Laxmi Publications, New Delhi.
2. Basak, N. N., Surveying and Levelling, McGraw Hill Education, New Delhi.
3. Kanetkar, T. P.; Kulkarni, S. V., Surveying and Levelling volume I, Pune Vidyarthi Gruh Prakashan.
4. Duggal, S. K., Survey I, McGraw Hill Education, New Delhi.
5. Saikia, M D.; Das. B.M.; Das. M.M., Surveying, PHI Learning, New Delhi.
6. Subramanian, R., Fundamentals of Surveying and Levelling, Oxford University Press. New Delhi.
7. Text Book of Surveying and Measurement   Vinod Kumar   FPH
8. Surveying   Sweta Kumari   FPH
9. Basic Surveying   Gopal krishnan   FPH

Mechanics of Materials

	Theory						Credits
Subject Code	**No. of Periods Per Week**			**Full Marks**	**:**	**100**	
2015303	**L**	**T**	**P/S**	**ESE**	**:**	**70**	**03**
	04	—	—	**TA**	**:**	**10**	
	—	—	—	**CT**	**:**	**20**	

Course Objective:

1. To learn properties of area and structural material properties.
2. To understand the concept of stress and strain.
3. To calculate shear force, bending moment for different shapes of structural elements and corresponding stresses.
4. To understand the concept of buckling loads for short and long columns.

COURSE OUTCOMES (COs):

1. Articulate practical applications of moment of inertia of symmetrical and unsymmetrical structural sections.
2. Analyze structural behavior of materials under various loading conditions.
3. Interpret shear force and bending moment diagrams for various types of beams and loading conditions.
4. Determine the bending and shear stresses in beams under different loading conditions.
5. Analyze the column for various loading and end conditions.

	CONTENTS: THEORY	Hrs
Unit -1	**Moment of Inertia**	
	1.1 Moment of inertia (M.I.): Definition, M.I. of plane lamina, Radius of gyration, section modulus, Parallel and Perpendicular axes theorems (without derivations), M.I. of rectangle, square, circle, semi-circle, quarter circle and triangle section (without derivations).	10
	1.2 M.I. of symmetrical and unsymmetrical I-section, Channel section, T-section, Angle section, Hollow sections and built-up sections about centroidal axes and any other reference axis.	
	1.3 Polar Moment of Inertia of solid circular sections.	
Unit -2	**Simple stresses and strains**	
	2.1 Definition of rigid, elastic and plastic bodies, deformation of elastic body under various forces, Definition of stress, strain, elasticity, Hook's law, Elastic limit, Modulus of elasticity.	
	2.2 Type of Stresses-Normal, Direct, Bending and Shear and nature of stresses i.e., Tensile and Compressive stresses.	
	2.3 Standard stress strain curve for tor steel bar under tension, Yield stress, Proof stress, Ultimate stress, Strain at various critical points, Percentage elongation and Factor of safety.	10
	2.4 Deformation of body due to axial force, forces applied at intermediate sections, Maximum and minimum stress induced, Composite section under axial loading.	
	2.5 Concept of temperature stresses and strain, Stress and strain developed due to tempera- true variation in homogeneous simple bar (no composite section)	
	2.6 Longitudinal and lateral strain, Modulus of Rigidity, Poisson's ratio, Biaxial and tri-axial stresses, volumetric strain, change in volume, Bulk modulus (Introduction only). Relation between modulus of elasticity, modulus of rigidity and bulk modulus (without derivation).	

Unit -3	**Shear force and Bending moment**	
	3.1 Types of supports, beams and loads	
	3.2 Concept and definition of shear force and bending moment, Relation between load, shear force and bending moment (without derivation).	10
	3.3 Shear force and bending moment diagram for cantilever and simply supported beams subjected to point loads, uniformly distributed loads and couple (combination of any two types of loading), point of contraflexure.	
Unit -4	**Bending and Shear stresses in beams**	
	4.1 Concept and theory of pure bending, assumptions, flexural equation (without derivation), bending stresses and their nature, bending stress distribution diagram.	
	4.2 Concept of moment of resistance and simple numerical problems using flexural equation.	
	4.3 Shear stress equation (without derivation), relation between maximum and average shear stress for rectangular and circular section, shear stress distribution diagram.	10
	4.4 Shear stress distribution for square, rectangular, circular, angle sections, channel section, I-section, T section. Simple numerical problems based on shear equation.	
Unit -5	**Columns**	
	5.1 Concept of compression member, short and long column, Effective length, Radius of gyration, Slenderness ratio, Types of end condition for columns, Buckling of axially loaded columns.	
	5.2 Euler's theory, assumptions made in Euler's theory and its limitations, Application of Euler's equation to calculate buckling load.	08
	5.3 Rankine's formula and its application to calculate crippling load.	
	5.4 Concept of working load/safe load, design load and factor of safety.	
	TOTAL	48

Suggested Text Book/ Reference Book:

1. Bedi D.S. Strength of Materials, Khanna Publishing House, Delhi, Ed. 2018
2. Timoshenko, S., Strength of Materials, Vol. I, CBS, New Delhi.
3. Khurmi, R.S., Strength of Materials, S Chand and Co. Ltd. New Delhi.
4. Ramamrutham, S, Strength of Materials, Dhanpat Rai and sons, New Delhi.
5. Punmia B C, Strength of Materials, Laxmi Publications (p) Ltd. New Delhi.
6. Rattan S.S., Strength of Materials, McGraw Hill Education; New Delhi.
7. Bansal R K, Strength of Materials, Laxmi Publications.
8. Subramaniam R, Strength of Materials, Oxford University Press.
9. Mechanics of Structure   Roshan Sinha   FPH
10. Mechanics of Materials   A.K.Ghosh   FPH

CONCRETE TECHNOLOGY

Subject Code 2015304	Theory						Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objective:
1. To know properties of cement and aggregate used in concrete.
2. To understand different characteristics of concrete.
3. To learn about role of admixtures in concrete.

COURSE OUTCOMES (COs):
1. Use different types of cement and aggregates in concrete
2. Prepare concrete of desired compressive strength.
3. Prepare concrete of required specification.
4. Maintain quality of concrete under different conditions.
5. Apply relevant admixtures for concreting

	CONTENTS: THEORY	Hrs
Unit -1	**Cement** 1.1 Physical Properties of OPC- fineness, standard consistency, setting time, compressive strength & soundness. 1.2 Testing of cement - fineness test, consistency test, setting time test, compressive strength test & soundness test, Storage of Cement and its effects on the properties of cement. 1.3 Types of Cements and their properties as per IS Specifications and their field applications- Ordinary Portland Cement (33, 43 and 53 grades), Portland Pozzolana Cement, Rapid Hardening Cement, Low Heat Cement, High Alumina Cement, Sulphate Resisting Cement, White Cement.	06
Unit -2	**Aggregates** 2.1 Aggregates: Source, Requirements of good aggregate, Classification according to size and shape. 2.2 Fine aggregates: Properties, size, specific gravity, bulk density, water absorption and bulking, fineness modulus and grading zone of sand, 2.3 Coarse aggregates: Properties, size, shape, surface texture, water absorption, soundness, specific gravity and bulk density, fineness modulus of coarse aggregate, grading of coarse aggregates, crushing value, impact value and abrasion value of coarse aggregates with specifications.	08

Unit – 3	**Concrete**	
	3.1 Definition of concrete, different grades of concrete (ordinary concrete, standard concrete & high strength concrete as per provisions of IS 456- 2000), minimum grade of concrete for different exposure conditions, minimum grade of concrete for R.C.C., water retaining structure & in sea water construction, durability of concrete.	10
	3.2 Water Cement ratio, Duff Abraham water cement (w/c) ratio law, significance of w/c ratio, selection of w/c ratio for different grades, maximum w/c ratio for different grades of concrete for different exposure conditions as per IS 456.	
	3.3 Properties of fresh concrete: - Workability,Factors affecting workability of concrete, Determination of workability of concrete by slump cone, compaction factor, Vee-Bee Consistometer. Value of workability requirement for different types of concrete works. Segregation, bleeding and preventive measures.	
	3.4 Properties of hardened concrete: - Compressive strength, durability, impermeability.	
Unit – 4	**Concrete mix design and testing of Concrete**	
	4.1 Concrete mix design, objectives, methods of mix design, study of mix design procedure by IS method as per IS 10262, (only procedural steps).	10
	4.2 Testing of hardened concrete: Significance of testing, determination of compressive strength of concrete cubes at different ages, interpretation & co relation of test results.	
	4.3 Non- Destructive Tests of concrete: Importance of NDT, Methods of NDT - Rebound hammer test, Ultrasonic pulse velocity test, working principle of rebound hammer and factor affecting the rebound index.	
Unit-5	**Quality control of concrete**	
	5.1 Concreting Operations: Batching, Mixing, Transportation, Placing, Compaction, Curing and finishing of concrete**.**	06
	5.2 Forms for concreting: Different types of form works for beams, slabs, columns, materials used for form work, requirement of good form work. Stripping time for removal of form works per IS 456	
	5.3 Waterproofing: Importance and need of waterproofing, methods of waterproofing and materials used for waterproofing.	
	5.4 Joints in concrete construction: Types of joints, methods for joining old and new concrete, materials used for filling joints.	

Unit-6	**Chemical Admixture, Special concrete and Extreme weather concreting**	
	6.1 Admixtures in concrete: Purpose, properties and application of different types of admixtures such as accelerating admixtures, retarding admixtures, water reducing admixtures, air entraining admixtures and super plasticizers.	
	6.2 Special Concrete: Properties, advantages and limitation of following types of Special concrete: Ready mix Concrete, Fiber Reinforced Concrete, High performance Concrete and light weight concrete.	08
	6.3 Cold weather concreting: effect of cold weather on concrete, precautions to be taken while concreting in cold weather condition.	
	6.4 Hot weather concreting: effect of hot weather on concrete, precautions to be taken while concreting in hot weather condition.	
	Total	48

Suggested Text Book/ **Reference Book:**

1. Gambhir, M.L., Concrete Technology, Tata McGraw Hill Publishing Co. Ltd., Delhi.

2. Shetty, M.S., Concrete Technology, S. Chand and Co. Pvt. Ltd., Ram Nagar, Delhi.

3. Santhakumar, A. R., Concrete Technology, Oxford University Press, New Delhi.

4. Neville, A. M. and Brooks, J.J., Concrete Technology, Pearson Education Pvt. Ltd.

5. Sood, H., Kulkarni P. D., Mittal L. N., Laboratory Manual in Concrete Technology, CBS Publishers, New Delhi.

6.	Concrete Technology	Gopal krishnan	FPH
7.	Concrete Technology	S.S.Ahuja	FPH

GEO TECHNICAL ENGINEERING

	Theory						Credits
Subject Code **2015305**	No. of Periods Per Week			Full Marks	:	100	03
	L	**T**	**P/S**	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objective:

1. To Understand and determine physical and index properties of soil.

2. To estimate permeability and shear strain of soil.

COURSE OUTCOMES (COs):

1. Analyze and classify soils.

2. Identify shear strength parameters for field conditions.

3. Understand the principles of compaction and its control.

4. Understand various stresses and their distribution in soil and other engineering properties of soil.

	CONTENTS: THEORY	Hrs.
Unit -1	**Overview of Geotechnical Engineering** 1.1 Definition of soil. 1.2 Importance of soil in Civil Engineering as construction material. 1.3 Field application of geotechnical engineering for foundation design, pavement design, design of earth retaining structures, design of earthen dams (brief ideas only).	04
Unit -2	**Physical and Index Properties of Soil** 2.1 Soil as a three phase system. 2.2 Water content, Determination of water content by oven drying method as per IS code. 2.3 Void ratio, porosity ,degree of saturation and density index. 2.4 Unit weight of soil mass – bulk unit weight, dry unit weight, unit weight of soil solids, saturated unit weight, submerged unit weight. 2.5 Determination of bulk unit weight and dry unit weight by core cutter method and sand replacement method as per IS code. 2.6 Specific gravity, determination of specific gravity by pycnometer. 2.7 Consistency of soil, Atterberg's limits of consistency: Liquid limit, plastic limit and shrinkage limit, plasticity index. 2.8 Determination of liquid limit, plastic limit and shrinkage limit as per IS code. 2.9 Particle size distribution, mechanical sieve analysis as per IS code, particle size distribution curve, effective diameter of soil, Uniformity coefficient and coefficient of curvature, well graded and uniformly graded soils.	10

Unit – 3	**Permeability of Soil**	
	3.1 Definition of permeability	
	3.2 Darcy's law of permeability, coefficient of permeability, typical values of coefficient of permeability for different soil.	10
	3.3 Factors affecting permeability	
	3.4 Determination of coefficient of permeability by constant head and falling head permeability tests, simple problems to determine coefficient of permeability.	
	3.5 Seepage through earthen structures, seepage velocity, seepage pressure, phreatic line, flow lines and equipotential lines.	
	3.6 Flow net, characteristics of flow net, application of flow net (no numerical problems).	
Unit – 4	**Shear strength of Soil**	
	4.1 Shear failure of soil, field situation of shear failure	
	4.2 Concept of shear strength of soil.	
	4.3 Components of shearing resistance of soil– cohesion, internal friction.	10
	4.4 Mohr-coulomb failure theory, Strength envelope, strength equation for purely. cohesive and cohesion less soils.	
	4.5 Laboratory determination of shear strength of soil – Direct shear test, Unconfined compression test & vane shear test, plotting strength envelope, determining shear strength parameters of soil.	
Unit – 5	**Bearing capacity of Soil**	
	5.1 Concept of bearing capacity, ultimate bearing capacity, safe bearing capacity and allowable bearing pressure.	
	5.2 Terzaghi's analysis and assumptions .	06
	5.3 Effect of water table on bearing capacity.	
	5.4 Field methods for determination of bearing capacity – Plate load test and standard penetration test. Test procedures as Per IS:1888 & IS:2131.	
	5.5 Definition of active earth pressure and passive earth pressure, structures subjected to earth pressure in the field.	
Unit – 6	**Compaction and stabilization of soil**	
	6.1 Concept of compaction, purpose of compaction, field situations where compaction is required.	
	6.2 Standard proctor test – test procedure as per IS code, Compaction curve, optimum moisture content, maximum dry density, Zero air voids line.	08
	6.3 Modified proctor test.	
	6.4 Factors affecting compaction.	
	6.5 Field methods of compaction – rolling, ramming & vibration.	
	6.6 California bearing ratio, CBR test, significance of CBR value.	
	6.7 Concept of soil stabilization, necessity of soil stabilization.	

	6.8 Different methods of soil stabilization – Mechanical soil stabilization, lime stabilization, cement stabilization, bitumen stabilization, fly-ash stabilization.	
	Total	48

Suggested Text book / Reference book:

1. Punmia, B.C., Soil Mechanics and Foundation Engineering, Laxmi Publication, Delhi.

2. Murthy, V.N.S., A text book of soil mechanics and foundation Engineering, CBS Publishers.

3. Ramamurthy, T.N. & SitharamT.G, Geotechnical Engineering (Soil Mechanics), S Chand

   and Company LTD., New Delhi.

4. Raj, P. Purushothama, Soil Mechanics and Foundation Engineering, Pearson India, New Delhi.

5. Kasamalkar, B. J., Geotechnical Engineering, Pune Vidyarthi Griha Prakashan, Pune.

6. Arora K R, Soil Mechanics and Foundation Engineering, Standard Publisher.

7. Geo-Technical Engineering   Kuldep Singh   FPH
8. Geo-Technical Engineering   K.N. Prasad   FPH
9. Geo-Technical Engineering   Ashok Jain   FPH

BASIC SURVEYING LAB

Subject Code	Practical						Credits
2015306	**No. of Periods Per Week**			**Full Marks**	**:**	**50**	
	L	**T**	**P/S**	**Internal(PA)**	**:**	**15**	**01**
	—	—	**02**	**External(ESE)**	**:**	**35**	

Course Objective:

1. To understand types of surveying works required.

2. To know the type of method and equipment to be used for different surveys.

3. To know the use and operational details of various surveying equipment.

Practical Outcomes:

1. Select the type of survey required for given situation.

2. Compute area of open field using chain, tape and cross staff.

3. Conduct traversing in the field using chain and compass.

4. Use levelling instruments to determine reduced level to prepare contour maps.

5. Use digital planimeter to calculate the areas.

CONTENTS: PRACTICAL

Preform any eight Experiments

1. Measure distance between two survey stations using chain, tape and ranging rods when two

   stations are inter visible.

2. Perform reciprocal ranging and measure the distance between two stations.

3. Determine area of open field using chain and cross staff survey.

4. Measure Fore Bearing and Back Bearing of survey lines of open traverse using Prismatic

   Compass.

5. Measure Fore Bearing and Back Bearing of a closed traverse of 5 or 6 sides and correct the bearings and

   included angles for the local attraction.

6. Undertake Survey Project with chain and compass for closed traverse for minimum 5 sides around a

   building**.**

7. Plot the traverse on A1 size imperial drawing sheet for data collected in Survey Project mentioned at

   practical **No.6.**

8. Undertake simple levelling using dumpy level/ Auto level and levelling staff.

9. Undertake differential levelling and determine Reduced Levels by Height of instrument method and Rise

   and fall method using dumpy level/Auto Level and levelling staff.

10. Undertake fly levelling with double check using dumpy level/ Auto level and levelling staff.

11. Undertake Survey Project for plotting contour map using block contouring method for a block of 150m x 150m with grid of 10m x10m.

12. Measure area of irregular figure using Digital planimeter

Reference Book:

1. Punmia, B.C, Jain, Ashok Kumar; Jain, Arun, Surveying Volume I, Laxmi Publications, New Delhi.

2. Basak, N. N., Surveying and Levelling, McGraw Hill Education, New Delhi.

3. Kanetkar, T. P.; Kulkarni, S. V., Surveying and Levelling volume I, Pune Vidyarthi Gruh Prakashan.

4. Duggal, S. K., Survey I, McGraw Hill Education, New Delhi.

5. Saikia, M D.; Das. B.M.; Das. M.M., Surveying, PHI Learning, New Delhi.

6. Subramanian, R., Fundamentals of Surveying and Levelling, Oxford University Press. New Delhi.

BUILDING CONSTRUCTION AND CONSTRUCTION MATERIALS LAB

Subject Code 2015307	Practical					Credits
	No. of Periods Per Week			Full Marks	:	50	
	L	T	P/S	Internal(PA)	:	15	01
	—	—	02	External(ESE)	:	35	

Course Objective:
1. To learn about various construction materials and understand their relevant characteristics.
2. To be able to identify suitability of various materials for different construction purposes.
3. To know about natural, artificial, and processed materials available for various purposes of construction activities.

Practical Outcomes:
1. Identify relevant construction materials.
2. Identify relevant natural construction materials.
3. Select relevant artificial construction materials.

CONTENTS: PRACTICAL

Perform any eight experiments:

1. Identify various sizes of available coarse aggregates from sample of 10 kg in laboratory and prepare report.

2. Prepare the lime putty by mixing lime (1 kg) with water in appropriate proportion and prepare report on slaking of lime.

3. Select first class, second class and third-class bricks from the stake of bricks and prepare report on the basis of its properties

4. Measure dimensions of 10 bricks and find average dimension and weight. Perform field tests- dropping, striking and scratching by nail and correlate the results obtained.

5. Identify different types of flooring tiles such as vitrified tiles, ceramic tiles, glazed tiles, mosaic tiles, anti- skid tiles and prepare report about the specifications.

6. Identify the type of glasses from the given samples.

7. Prepare the cement mortar of proportion 1:3 or 1:6 using cement and sand.

8. Preparing foundation plan and marking on ground layout of load bearing structure by face line method from the given plan of the building

9. Preparing foundation plan and marking on ground layout of framed structure by face line method from the given Plan of the building

10. Observing and writing report of the process of plastering.

Reference Book:
1. Ghose, D. N., Construction Materials, Tata McGraw Hill, New Delhi.
2. S.K. Sharma, Civil Engineering Construction Materials, Khanna Publishing House, New Delhi
3. Varghese, P.C., Building Materials, PHI learning, New Delhi.
4. Rang Wala, S.C., Engineering Materials, Cha rotor publisher, Ahmedabad.
5. Rajput, R.K, Engineering Materials, S. Chand and Co., New Delhi.
6. Sood H., Laboratory Manual on Testing of Engineering Materials, New Age Publishers, New Delhi.
7. Sharma C. P., Engineering Materials, PHI Learning, New Delhi.
8. Duggal, S. K, Building Materials, New International, New Delhi

WEB TECHNOLOGY LAB

Subject Code	Practical					Credits
2018308	**No. of Periods Per Week**		**Full Marks**	**:**	**25**	**01**
	L	**T**	**P/S**	**Internal(PA)**	**:**	**07**	
	—	—	**02**	**External(ESE)**	**:**	**18**	

Course Learning Objectives:

This Lab course is intended to practice whatever is taught in theory class of 'Web Technologies'. Some of the things that should necessary be covered in lab.

Course outcomes:

Student will be able to program web applications using and will be able to do the following:

- Use LAMP Stack for web applications
- Write simple applications with Technologies like HTML, Java script, AJAX, PHP
- Connect to Database and get results
- Parse XML files Student will be able to develop/build a functional website with full features.

Content: Practical		**Hrs.**	**Marks**
Unit – 1	Home page Development static pages (using Only HTML) of an online Book store.	04	
Unit – 2	Write a JavaScript to design a simple calculator to perform the following operations: sum, product, difference and quotient.	06	
Unit – 3	Write a PHP program to display a digital clock which displays the current time of the server.	06	
Unit – 4	Write an HTML code to display your CV on a web page.	04	
Unit – 5	Write an XML program to display products.	05	
Unit – 6	Create a web page with all types of Cascading style sheets.	06	
Unit – 7	Write a PHP program to display a digital clock which displays the current time of the server.	05	
Unit – 8	Write a JavaScript that calculates the squares and cubes of the numbers from 0 to 10 and outputs HTML text that displays the resulting values in an HTML table format.	04	

This is a skill course. More student practice and try to find solution on their own, better it will be.

Reference Books:

1. "Web Technologies--A Computer Science Perspective", Jeffrey C.Jackson

2. "Internet & World Wide Web How to Program", Deitel, Goldberg, Pearson Education

3. "Web programming- Building Internet Application", Chris Bales

4. Web Applications: Concepts and Real-World Design, Knuckles

Mechanics of Materials Lab (TW)

Subject Code	Term Work						Credits
2015309	**No. of Periods Per Week**			Full Marks	:	25	**01**
	L	T	P/S	Internal(PA)	:	07	
	—	—	02	External(ESE)	:	18	

Course Objective:
1. To know the procedure for the conduct of tensile and compressive strength.
2. To understand the concept of stress and strain through testing of different materials.
3. To calculate shear force, bending moment and their corresponding stresses.
4. To understand flexural strength of floor tiles.

Term Work Outcomes:
1. Test different Civil engineering materials on Universal Testing Machine.
2. Analyze structural behavior of materials under various loading conditions.
3. Interpret shear force and bending moment diagrams for various types of beam sections and different loading conditions.
4. Determine bending and shear stresses in beams under different loading conditions.
5. Calculate flexural strength of different types of floor tiles

CONTENTS: -TERM WORK

Preform any eight Experiments

1. Study different components of Universal Testing Machine (UTM).

2. Perform Tension test on mild steel as per IS:432(1).

3. Perform tension test on Tor steel as per IS:1608, IS:1139.

4. Conduct compression test on sample test piece using Compression Testing Machine.

5. Conduct Izod Impact test on three metals. e.g., mild steel/ brass/aluminum/ copper /cast iron as per IS:1598.

6. Conduct Charpy Impact test on three metals. e.g., mild steel/ brass/aluminum/ copper /cast iron as per IS:1757.

7. Determine Water Absorption on bricks as per IS:1077

8. Determine Compressive strength of dry and wet bricks as per IS:3495(part I), IS:1077

9. Conduct Abrasion Test on flooring tiles (any one) e.g., Mosaic tiles, Ceramic Tiles Cement Tile.

10. Perform Single Shear and double shear test on any two metals e.g., Mild steel/ brass/aluminum/copper / cast iron as per IS:5242.

11. Plot Shear force and Bending Moment diagrams for cantilever, simply supported beams for different types of loads.

12. Plot Shear force and Bending Moment diagrams for overhanging beams for different types of loads including moment loading.

13. Conduct Flexural test on timber beam on rectangular section in both orientations as per IS:1708, IS:2408.

14. Conduct Flexure test on floor tiles IS:1237 or roofing tiles as per IS:654.

Reference Book:

1. Bedi D.S., Strength of Materials, Khanna Publishing House, New Delhi (Edition 2018)
2. Timoshenko, S., Strength of Materials, Vol. I, CBS, New Delhi.
3. Khurmi, R.S., Strength of Materials, S Chand and Co. Ltd. New Delhi.
4. Ramamrutham, S, Strength of Materials, Dhanpat Rai and sons, New Delhi.
5. Punmia B C, Strength of Materials, Laxmi Publications (p) Ltd. New Delhi.
6. Rattan S.S., Strength of Materials, McGraw Hill Education; New Delhi.
7. Bansal R K, Strength of Materials, Laxmi Publications.
8. Subramaniam R, Strength of Materials, Oxford University Press.

Concrete Technology Lab (TW)

Subject Code	Term Work						Credits
2015310	**No. of Periods Per Week**			Full Marks	:	25	01
	L	**T**	**P/S**	Internal(PA)	:	07	
	—	—	02	External(ESE)	:	18	

Course Objective:
1. To know properties of cement and aggregate used in concrete.
2. To understand different characteristics of concrete.
3. To learn about preparation of Concrete.

Term Work Outcomes:
1. Identify different types of cement by performing laboratory tests.
2. Know the physical properties of fine and coarse aggregates.
3. Prepare concrete of required grade.

Contents: - Term Work

Preform any eight Experiments

1. Determine fineness of cement by Blaine's air permeability apparatus or by sieving.

2. Determine specific gravity, standard consistency, initial and final setting times of cement.

3. Determine compressive strength of cement.

4. Determine silt content in sand.

5. Determine bulking of sand.

6. Determine bulk density of fine and coarse aggregates.

7. Determine water absorption of fine and coarse aggregates.

8. Determine Fineness modulus of fine aggregate by sieve analysis.

9. Determine impact value of aggregate.

10. Determine crushing value of aggregate.

11. Determine abrasion value of aggregate.

12. Determine elongation and flakiness index of coarse aggregates.

13. Determine workability of concrete by slump cone test.

14. Determine workability of concrete by compaction factor test.

15. To prepare concrete mix of a particular grade and determine compressive strength of concrete for 7 and 28 days.

16. Demonstration of NDT equipment.

Reference Book:
1. Gambhir, M.L., Concrete Technology, Tata McGraw Hill Publishing Co. Ltd., Delhi.
2. Shetty, M.S., Concrete Technology, S. Chand and Co. Pvt. Ltd., Ram Nagar, Delhi.

TERM WORK
PYTHON (TW)

Subject Code	Term Work						Credits
2018311	No. of Periods Per Week			Full Marks	:	25	01
	L	T	P/S	Internal(PA)	:	07	
	—	—	02	External(ESE)	:	18	

	CONTENTS: Practical	Hrs.	Marks
UNIT – 01	Write a program to demonstrate basic data type in python.		
UNIT – 02	Write a program to computedistance between two pointstaking input from the user (Pythagorean Theorem)		
UNIT – 03	Write a python program Using for loop, write a program thatprints out the decimal equivalent of 1+½+1/3….1/n		
UNIT – 04	Write a Python program to find first n prime numbers. Write a program to demonstrate list and tuple inpython.		
UNIT – 05	Write a program using a for loop that loops over a sequence. Write a program using a while loop that asks the user for a number and prints a countdown from that number to zero.		
UNIT – 06	Write a Python Program to add matrices. Write a Python program to multiply matrices.		
UNIT – 07	Write a Python program tocheck if a string is palindrome or not.		
UNIT – 08	Write a Python program toExtract Unique values dictionary values		
UNIT – 09	Write a Python program to read file word by word Write a Python program to Get number of characters, words.		
UNIT – 10	Write a Python program for Linear Search		

References Books:

1. Taming Python by Programming, Jeeva Jose, Khanna Publishing House

2. Starting Out with Python, Tony Gaddis, Pearson

3. Core Python Programming, Wesley J. Chun, Prentice Hall

4. Python Programming: Using Problem Solving Approach, Reema Thareja, Oxford University

5. Introduction to Computation and Programming Using Python. John V. Gut tag, MIT Press.

Geo Technical Eng. Lab (TW)

Subject Code 2015312	Term Work						Credits
	No. of Periods Per Week			Full Marks	:	50	01
	L	T	P/S	Internal(PA)	:	15	
	—	—	02	External(ESE)	:	35	

Course Objectives:

-
1. To understand and determine physical properties of soil.
2. To estimate the permeability and shear strength of soil.
3. To know the procedure for performing C.B.R test.

Term Work outcomes:

- Interpret the physical properties of soil.

  Use the results of permeability and shear strength test for foundation analysis.

- Compute optimum moisture content values for maximum dry density of soil through various tests.

Contents: - Term Work

Preform any eight Experiments

1. Determination of water content of given soil sample by oven drying method as per IS Code.

2. Determination of bulk unit weight, dry unit weight of soil in field by core cutter method as per IS Code.

3. Determination of specific gravity of soil by Pycnometer method.

4. Determination of bulk unit weight, dry unit weight of soil in field by sand replacement method as per IS Code.

5. Determination of Liquid limit & Plastic limit of given soil sample as per IS Code.

6. Determination of grain size distribution of given soil sample by mechanical sieve analysis as per IS Code.

7. Determination of coefficient of permeability by constant head test.

8. Determination of coefficient of permeability by falling head test.

9. Determination of shear strength of soil using direct shear test.

10. Determination of shear strength of soil using Laboratory Vane shear test.

11. Determination of MDD & OMC by standard proctor test on given soil sample as per IS Code.

12. Determination of CBR value of given soil sample.

<u>Suggested Text Books: -</u>

1. Soil Mechanics and Foundation Engineering – B.C. Punmia, Laxmi Publications (P) Ltd.
2. Textbook of Soil Mechanics and Foundation Engineering – V.N.S. Murthy, CBS Publishers & Distributors Pvt. Ltd

STATEBOARDOFTECHNICALEDUCATION,BIHAR

SchemeofTeaching andExaminationsfor
IVᵗʰSemesterDiplomainCivilEngineering/Civil(Rural)Engineering
(Effective from Session 2020-21 Batch)
Rev 1.0 THEORY

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME							
			Periodsper Week	Hours ofExam.	Teacher's Assessment(TA) Marks A	Class Test(CT) Marks B	EndSemester Exam.(ESE) Marks C	Total Marks(A+B+C)	Pass Marks ESE	Pass Marks in theSubject	Credits
1.	Hydraulics	2015401	03	03	10	20	70	100	28	40	03
2.	AdvanceSurveying	2015402	03	03	10	20	70	100	28	40	03
3.	Theoryof structure	2015403	03	03	10	20	70	100	28	40	03
4.	BuildingPlanning andDrawing	2015404	03	04	10	20	70	100	28	40	03
5.	Transportation Engineering	2015405	03	03	10	20	70	100	28	40	03
		Total:-	15				350	500			15

PRACTICAL

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME				
			Periods perWeek	Hours ofExam.	Practical(ESE)		Total Marks (A+B)	PassMarks in theSubject	Credits
					Internal(PA) A	External(ESE) B			
6.	HydraulicsLab	2015406	02 50%Physical 50% Virtual	03	15	35	50	20	01
7.	AdvanceSurveyingLab	2015407	02 50%Physical 50% Virtual	04	15	35	50	20	01
	Total :-		04				100		02

TERMWORK

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME	EXAMINATION-SCHEME				
			Periods perWeek	Marks ofInternalExaminer(PA) X	Marks ofExternalExaminer(ESE) Y	Total Marks (X+Y)	Pass Marksin theSubject	Credits
8.	Theory ofstructureLab(TW)	2015408	04	07	18	25	10	02
9.	BuildingPlanningand Drawing(TW)	2015409	04	15	35	50	20	02
10.	Transportation EngineeringLab(TW)	2015410	02	07	18	25	10	01
11.	Course AutoCAD/STAAD. Pro/ Others(TW)	2015411	04	15	35	50	20	02
	Total :-		14			150		07
TotalPeriodsperweekEachofdurationOneHour			33	TotalMarks=		750		24

HYDRAULICS

	Theory						Credits
SubjectCode	**No.of Periods PerWeek**			**FullMarks**	**:**	**100**	
2015401	**L**	**T**	**P/S**	**ESE**	**:**	**70**	**03**
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

CourseObjective:

    1. Tounderstandparametersassociatedwithfluidflowandhydrostaticpressure.

    2. Toknowheadlossand water hammer influidflowingthroughpipes.

    3. Tolearndifferent types ofpumpsandtheiruses

CONTENTS:THEORY

	Nameof theTopic	Hrs.
Unit-1	**PressuremeasurementandHydrostaticpressure** 1.1 Technical termsusedinHydraulics–fluid, fluidmechanics,hydraulics, hydrostaticsandhydrodynamics–ideal andrealfluid,applicationofhydraulics. 1.2 Physicalpropertiesoffluid– density,specificvolume,specificgravity,SpecificWeight,relativedensity,compressibility, cohesion,adhesion,surfacetension,capillarity,viscosity-Newton'slaw ofviscosity. 1.3 Varioustypesofpressure–AtmosphericPressure,GaugePressure,AbsolutePressure, Vacuum Pressure. Concept ofPressure head and its unit, Conversion fromintensity of pressure to pressure headandvice-versa,Formulaand Simple problems,Pascal'slaw offluid pressure andits uses. 1.4 MeasurementofdifferentialPressurebydifferentmethods. 1.5 Variationofpressurewithdepth,Pressurediagram,hydrostaticpressureandcenterofpressur eonimmersed surfaces and ontankwalls. 1.6 DeterminationoftotalpressureandcenterofpressureonsidesandbottomOfwatertanks,sides andbottomoftankscontainingtwoliquids,verticalsurfaceincontact withliquidoneither side.	08
Unit-2	**FluidFlowParameters** 2.1 Typesofflow,Gravityandpressureflow,Laminar,Turbulent,Uniform,non-uniform,Steady,Unsteadyflow. Reynoldsnumber. 2.2 Dischargeanditsunit,continuityequationofflow. 2.3 Energyofflowingliquid:potential,kineticandpressureenergy. 2.4 Bernoulli'stheorem:statement,assumptions,equation. 2.5 Application of Bernoulli's theorem: Venturi meter , Orifice meter, Pitot Tube 2.6 Momentum Equation.Simplenumericalproblemsbasedonabovetopics.	10

Unit–3	**Flow throughpipes**	
	3.1 Majorheadlossinpipe:FrictionallossanditscomputationbyDarcy'sWeisbachequation,Use ofMoody'sDiagram.	10
	3.2 Minorlossesinpipe:lossatentrance,exit,suddencontraction,suddenenlargementandfittings.	
	3.3 Flowthroughpipesinseries,pipesinParallelandDupuit'sequationforequivalentpipe.	
	3.4 Hydraulicgradientlineandtotal energyline.	
	3.5 Water hammerinpipes:CausesandRemedialmeasures.	
	3.6 Dischargemeasuringdeviceforpipeflow:Venturimeter -constructionandworking.	
	3.7 DischargemeasurementusingOrifice,HydraulicCoefficientsofOrifice.Simplenumerical problemsbasedon above topics.	
Unit– 4	.**FlowthroughOpen Channel**	
	4.1 Comparisonof PipeFlow&OpenChannelflow.	
	4.2 Classification of Channel, Classification of flow, Geometrical properties of channelsection:Wettedarea,wettedperimeter,hydraulicradiusforrectangularandtrapezoidal channelsection.	
	4.3 DeterminationofdischargebyChezy'sequationandManning'sequation.	08
	4.4 ConditionsformosteconomicalRectangularandTrapezoidalchannelsection.	
	4.5 SpecificEnergyDiagram,Froude'sNumberanditssignificance.	
	4.6 Critical,Sub-Critical&SuperCriticalFlowinChannel.	
	4.7 HydraulicJumpanditsoccurrenceinthefield.PracticalapplicationsofHydraulicJump.	
	4.8 Dischargemeasuringdevices:TriangularandrectangularNotches,Derivationofequationsfor discharge,Comparison of Rectangular&V-Notch.	
	4.9 Velocitymeasurementdevices:currentMeter,floatsandPitot'stube.Simple NumericalProblemsbasedonabovetopics.	
Unit– 5	**HydraulicMachines**	
	5.1 Conceptofpump,Typesofpump- Centrifugal,Reciprocating,submersible.Advantages&Disadvantages, Priming.	12
	5.2 Suctionhead,deliveryhead,statichead,Manometrichead.	
	5.3 Powerofcentrifugal pump.	
	5.4 Selectionandchoiceofpump.	
	5.5 Turbines:Definition&Types.DifferencebetweenPump&Turbines.	
	Total	48

SuggestedText Book:

1. Modi,P.N.andSeth,S.M.,HydraulicsandFluidMechanics,Standardbookhouse, Delhi

2. R.K.Bansal,AText bookof FluidMechanics &Hydraulic Machines,LaxmiPublications Pvt.Ltd.

3. R.L.Anand,Hydraulics,FoundationPublishingHouse.

COURSEOUTCOMES(COs):

1:Measurepressureanddeterminetotalhydrostaticpressurefordifferentconditions.2:

Understand variousparametersassociated withfluidflow.

3: Determine head loss of fluid flow through

pipes.4:Findthefluidflowparametersinopenchannels

.

5:Selectrelevanthydraulicpumpsfordifferentapplications**.**

CO PO MAPPING

Co Number	CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
C2015401.01	Measurepressureanddeterminetotalhydrostaticpressurefordifferentconditions	3	2	-	-	1	-	-
C2015401.02	Understand variousparametersassociated withfluidflow.	3	1	1	-	-	-	2
C2015401.03	Determine head loss of fluid flow through pipes.	3	2	-	-	-	-	1
C2015401.04	Findthefluidflowparametersinopenchannels.	3	2	1	1	1	-	-
C2015401.05	Selectrelevanthydraulicpumpsfordifferentapplications**.**	2	1	-	-	-	1	2
Average		2.8	1.6	1	1	1	1	1.66

ADVANCESURVEYING

SubjectCode 2015402	Theory						Credits 03
	No.of Periods PerWeek			FullMarks	:	100	
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

CourseObjective:
- To knowmethods of planesurveying and Theodolite surveying and their uses.
- Tolearntacheometricsurveying andcurvesetting
- To understand the principles of Electronic Distance Measurement equipment and totalstation and theiruse.
- Toknowthe conceptofremotesensing, GPSandGIS

Contents:Theory

	NameoftheTopic	Hrs.
Unit-1	**PlaneTable Surveying:** 1.1 Principles of plane table survey. Accessories of plane table and their use, Telescopicalidade. 1.2 Settingofplanetable;Orientationofplanetable-BacksightingandMagneticmeridianmethod. 1.3 Methodsofplanetablesurveys-Radiation,IntersectionandTraversing. Meritsanddemeritsofplanetablesurvey.	10
Unit-2	**TheodoliteSurveying:** 2.1 TypesandusesofTheodolite,ComponentsoftransitTheodoliteandtheirfunctions,Reading the VernieroftransitTheodolite. 2.2 TemporaryadjustmentoftransitTheodolite. 2.3 Measurementofhorizontalangle-DirectandRepetitionmethod,Errorseliminatedby methodofrepetition. 2.4 MeasurementofverticalAngle. 2.5 Traversecomputation-Latitude,Departure,Consecutivecoordinates,independentcoordinates,balancingthetra versebyBowditch'sruleandTransitrule,Gale's Traversetablecomputation.	12
Unit– 3	**TacheometricSurveyingandCurve Setting:** 3.1 Principlesof Tacheometry,Tacheometeranditscomponentparts,Anallaticlens. 3.2 Tacheometric formula for horizontal distance with telescope horizontal and staffvertical. 3.3 Field method for determining constants of tacheometer, determining horizontal andvertical Distances with tacheometer by fixed Hair method and staff held vertical,Limitationsoftacheometry. 3.4 Typesofcurvesusedinroadsandrailwayalignments.Designationofcurves.Setting simple circular curve by offsets from long chord and Rankine's method of deflectionangles.	10

Unit– 4	**AdvanceSurveyingEquipment's:**	
	4.1 PrincipleofElectronicDistanceMeter(EDM)itscomponentpartsandtheirFunctionsuseof EDM.	08
	4.2 UseofElectronicDigitalTheodolite.	
	4.3 UseofTotal Station,Use offunctionkeys.	
	4.4 MeasurementsofHorizontalangles,verticalangles,distancesandcoordinatesusingTotal Station, Traversing, ProfileSurvey and ContouringwithTotal Station.	
Unit–5	**RemoteSensing,GPSandGIS:** 5.1 RemoteSensing– Overview,Remotesensingsystem,ApplicationsofremotesensinginCivilengineering.	08
	5.2 UseofGlobalPositioning System(G.P.S.)instruments.	
	5.3 Geographic Information System (GIS): Over view, Components, Applications, SoftwareforGIS.	
	5.4 IntroductiontoDroneSurveying.	
	Total	48

COURSEOUTCOMES(COs):

- PrepareplansusingPlaneTableSurveys.
- PrepareplansusingTheodolitesurveys.
- FinddistancesandelevationsusingTacheometer.
- Prepareplans usingTotalStationinstrument.
- LocatecoordinatesofstationsusingGPS.

CO PO MAPPING

Co Number	CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C2015402.01	PrepareplansusingPlaneTableSurveys.	-	-	-	-	3	-	1
C2015402.02	PrepareplansusingTheodolitesurveys	1	3	-	-	-	-	-
C2015402.03	FinddistancesandelevationsusingTacheometer	1	3	-	-	-	-	-
C2015402.04	Prepareplans usingTotalStationinstrument	2	-	-	2	-	-	-
C2015402.05	Locate coordinates of stations using GPS.	-	-	1	3	1	-	-
Average		1.33	3	1	2.5	2		1

SuggestedText Book/ReferenceBook:

1. Kanetkar T.P.; Kulkarni S.V., Surveying and Levelling PartIandII, Pune Vidyarthi Gruh Prakashan,Pune.
2. BasakN.N., SurveyingandLevelling,McGrawHillEducation(India)Pvt.Ltd.,Noida.
3. DuggalS.K., SurveyIandSurvey II,TataMcGraw HillEducationPvt.Ltd.Noida.
4. SaikiaMD.;Das. B.M.;Das.M.M.,SurveyingPHILearningPvt.Ltd.,NewDelhi.
5. R.,SurveyingandLevelling, OxfordUniversityPress.NewDelhi.
6. Punnia, B.C., Jain, Ashok Kumar, Jain Arun Kumar, Surveying Vol-I and II,Laxmi,Publication Pvt. Ltd, New Delhi.
7. SwetaKumari,Advance Surveying,FPH
8. P.L.Bhatia, AdvanceSurveying ,FPH

THEORY OF STRUCTURE

SubjectCode	Theory						Credits
SubjectCode **2015403**	**No.of Periods PerWeek**			**FullMarks**	**:**	**100**	**03**
	L	**T**	**P/S**	**ESE**	**:**	**70**	
	03	—	—	**TA**	**:**	**10**	
	—	—	—	**CT**	**:**	**20**	

CourseObjective:
- Tolearnconceptofeccentricloadingandstresses inverticalmembers likecolumn,chimneys,dam.
- Toanalyzebeamsusingvariousmethodslikeslopedeflection,threemomentandmomentdistribution.
- Tounderstanddifferentmethodsoffindingaxialforcesintrusses.

Contents:Theory

	NameoftheTopic	Hrs.
Unit-1	**DirectandBending stresses in Verticalmembers:** 1.1 Conceptofdirectandeccentricloads,eccentricityaboutoneprincipalaxis,natureofstresses,maximum andminimumstresses,resultantstressdistributiondiagram. 1.2 Conditionfornotensionorzerostressatextremefiber,Limitofeccentricity,coreof section forrectangularand circularcrosssections,Middlethirdrule. 1.3 Column,pillar,chimneyofuniformcrosssectionsubjectedtolateralwindpressure,Coefficientofwindresistance&resultantstressdistributionattheirbases.	08
Unit-2	**Slopeand deflection:** 2.1 Conceptofslopeanddeflection,stiffness ofBeam. 2.2 Relation between bending moment, slope, deflection & radius of curvature(noderivation) 2.3 Doubleintegrationmethodtofindslopeanddeflectionofsimplysupportedandcantilever beamsubjectedto concentratedanduniformly distributedload. 2.4 Macaulaymethodtofindslopeanddeflectionofsimplysupportedandcantileverbeamsubjectedtoconcentratedand uniformlydistributedload.	10
Unit−3	**Fixedandcontinuous Beam:** 3.1 DifferenttypesofDeterminate&IndeterminateStructures&Stabilityofstructure. 3.2Concept of fixity, effect of fixity, advantages and disadvantages of fixed beam oversimplysupportedbeam. 3.3 Principleofsuperposition,Fixedendmomentsfromfirstprincipleforbeamsubjectedto pointload,UDLoverentire span. 3.4 Applicationofstandardformulaeinfindingendmoments,endreactionsanddrawing S.F. and B.M. diagrams for a fixed beam. (Derivation need not to be askedin exam). 3.5 Clapeyron's theorem of three moments (no derivation). Application of theoremmaximum up to three spans and two unknown support moment only, Support at samelevel, spans having same & uniform moment of inertia subjected to concentrated loadsanduniformly distributedloadsoverentire span. 3.6 DrawingSF &BMdiagramsshowingpointofcontraflexureforcontinuousbeams.	14
Unit−4	**Momentdistributionmethod:** 4.1 Introduction,signconvention. 4.2 Carryoverfactor,stiffnessfactor,Distributionfactor. 4.3 Applicationofmomentdistributionmethodforvarioustypesofcontinuousbeamssubjectedtoconcentratedloadsanduniformlydistributedloadoverentirespan havingsameordifferentmomentofinertiauptothreespansandtwounknownsupportmomentonly.	10
Unit−5	**Simpletrusses:** 5.1 Typesoftrusses(Simple,Fink,compoundfink,Frenchtruss,pratttruss,Howetruss, Northlighttruss, Kingpostand Queenposttruss). 5.2 Calculatesupportreactionsfor trussessubjectedtopoint loadsatjoints 5.3 CalculateforcesinmembersoftrussusingMethodofjointsandMethodofsections.	06
	Total	48

COURSEOUTCOMES(COs):

1. Analyzestressesinducedinverticalmembersubjectedtodirectandbendingloads.
2. AnalyzeslopeandDeflectioninfixedandcontinuousbeams. and compare with permissible limits according to IS code
3. AnalyzecontinuousbeamusingMomentDistributionMethodunderdifferentloadingconditions.
4. Evaluateaxialforcesinthemembersofsimpletruss.

CO PO MAPPING

Co Number	CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C2015403.01	Analyze stresses induced in vertical member subjected to direct and bending loads	2	3	-	-	-	-	-
C2015403.02	Analyze slope and Deflection in fixed and continuous beams. and compare with permissible limits according to IS code	1	3	1	-	2	-	1
C2015403.03	Analyze continuous beam using Moment Distribution Method under different loading conditions.	2	3	1	-	-	-	-
C2015403.04	Evaluate axial forces in the members of simple truss.	1	3	3	-	-	-	2
Average		1.5	3	1.66		2		1.5

SuggestedTextBook:

1. Theoryofstructures,S.Ramamrutham,Dhanpatrai&Sons.
2. Mechanicsofstructures,S.B.JunnarkarCharotarPublishingHouse,Anand.
3. AnalysisofStructuresV.N.Vazirani&M.M.Ratwani
4. TheoryofStructuresR.S.Khurmi,S.ChandandCo.,NewDelhi.
5. TheoryofStructure,R.S.Guha,FPH

BUILDINGPLANNINGANDDRAWING

SubjectCode 2015404	Theory						Credits
	No.of Periods PerWeek			FullMarks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

CourseObjective:

1. Tolearnbasicprinciplesofbuildingplanninganddrawing.
2. Toknowgraphicalrepresentationofvariouscomponentsofbuildings.
3. Todrawcompleteplanandelevationofabuilding.
4. TolearnbasicsofperspectivedrawingsandComputerAidedDrawings

Contents:Theory

	Nameofthe Topic	Hrs.
Unit -1	**Conventions and Symbols:** 1.1 Conventions as per IS 962, symbols for different materials such as earth work, brick work, Stone work, concrete, wood work and glass. 1.2 Graphical symbols for doors and windows, Abbreviations, symbols for sanitary and electrical installations. 1.3 Types of lines-visible lines, centre line, hidden line, section line, dimension line, extension line, pointers, arrow head or dots. Appropriate size of lettering and numerals for titles, sub-titles notes and dimensions. 1.4 Types of scale, criteria for Proper Selection of scale for various types of drawing. 1.5 Sizes of various standard papers/sheets.	04
Unit -2	**Planning of Building:** 2.1 Principles of planning for Residential and Public building- Aspect, Prospect ,Orientation, Grouping ,Privacy ,Elegance ,Flexibility ,Circulation, Furniture requirements ,Sanitation, Economy. 2.2 Space requirement and norms for minimum dimension of different units in the residential and public buildings as per IS 962. 2.3 Rules and bye-laws of sanctioning authorities for construction work. 2.4 Plot area, built up area, super built-up area, plinth area, carpet area, floor area and FAR (Floor Area Ratio). 2.5 Line plans for residential building of minimum three rooms including water closet (WC), bath and stair case as per principles of planning. 2.6 Line plans for public building-school building, primary health centre, hostel and Library.	10
Unit – 3	**Drawing of Load Bearing Structure:** 3.1 DrawingofSingle-storyLoadBearingresidentialbuilding(2BHK)withstaircase. 3.2 Data drawing–plan, elevation, section, site plan, schedule of openings, constructionnotes with specifications, area statement, Planning and design of stair case- Rise andTreadforresidentialandpublic building. 3.3 Working drawing–developed plan, elevation, section passing through stair case or WCand bath. Foundationplanof Loadbearingstructure.	16

Unit – 4	Drawing of Framed Structure:	
	4.1 Drawing of Two storied Framed Structure (G+1), residential building (2BHK) with staircase.	
	4.2 Data drawing – developed plan, elevation, section, site plan, schedule of openings, construction notes with specifications, area statement.	
	4.3 Working drawing of Framed Structure – developed plan, elevation, section passing through stair case or WC and bath.	14
	4.4 Foundation plan of Framed Structure.	
	4.5 Details of RCC footing, Column, Beam, Chajjas, Lintel, Staircase and slab.	
	4.6 Drawing with CAD-Draw commands, modify commands, layer commands.	
Unit – 5	Perspective Drawing:	
	8.1 Definition of perspective drawing, Types of perspective, terms used in perspective drawing, principles used in perspective drawing.	04
	8.2 Two Point Perspective of small objects only such as steps, monuments, pedestals.	
	Total	48

COURSE OUTCOMES (COs):

1. Interpret the symbols, signs and conventions from the given drawing.
2. Prepare line plans of residential and public buildings using principles of planning.
3. Prepare submission and working drawing for the given requirement of Load Bearing structure
4. Prepare submission and working drawing using CAD for the given requirement of Frame structure
5. Draw two-point perspective drawing for given small objects.

CO PO MAPPING

Co Number	CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C2015404.01	Interpret the symbols, signs and conventions from the given drawing	2	2	-	-	-	-	-
C2015404.02	Prepare line plans of residential and public buildings using principles of planning	2	2	3	-	-	-	-
C2015404.03	Prepare submission and working drawing for the given requirement of Load Bearing structure	2	2	3	2	1	-	-
C2015404.04	Prepare submission and working drawing using CAD for the given requirement of Frame Structure	2	-	-	3	-	-	-
C2015404.05	Draw two-point perspective drawing for given small objects.	2	-	-	-	-	-	2
Average		2	2	3	2.5	1		2

Suggested TextBook/ReferenceBook:

2. Malik and Mayo, Civil Engineering Drawing, Computech Publication Ltd New Asian Publishers, New Delhi.
3. M.G. Shah and C.M. Kale, Principles of Perspective Drawing, McGraw Hill Publishing company Ltd. New Delhi.
4. Swamy, Kumara; Rao, N, Kameshwara, A. Building Planning and Drawing, Charotar Publication, Anand.
5. Bhavikatti, S.S., Building Construction, Vikas Publication House Pvt. Ltd., New Delhi.
6. Mantri, Sandip, A to Z Building Construction, Satya Prakashan, New Delhi.
7. Singh, Ajeet, Working with AutoCAD 2000, McGraw Hill Publishing company Ltd. New Delhi. Sane, Y.S., Planning and design of Building, Allied Publishers, New Delhi
8. R.P. Duggal, Building Planning and Drawing, FPH

TRANSPORTATION ENGINEERING

SubjectCode 2015405	Theory						Credits
	No.of Periods PerWeek			FullMarks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

CourseObjective:

1. ToidentifythetypesofroadsasperIRCrecommendations.
2. Tounderstandthegeometricaldesignfeaturesofdifferenthighways.
3. Toperformdifferenttestsonroadmaterials.
4. Toidentifythecomponentsofrailwaytracks

Contents:Theory

	NameoftheTopic	Hrs.
Unit-1	**OverviewofHighway Engineering** 1.1 Roleoftransportationinthedevelopmentofnation,Scopeand ImportanceofroadsinIndia. 1.2 Differentmodesoftransportation– landway,waterway,airway.Meritsanddemeritsofroadway andrailway. 1.3 Generalclassificationofroads. 1.4 Selectionandfactorsaffectingroadalignment.	04
Unit-2	**GeometricDesignofHighway** 2.1 Camber:Definition,purpose,typesasperIRC–recommendations. 2.2 Kerbs:Roadmargin,roadformation,rightofway. 2.3 DesignspeedandvariousfactorsaffectingdesignspeedasperIRC– Recommendations. 2.4 Gradient:Definition,typesasperIRC–Recommendations. 2.5 Sightdistance:Definition,typesasperIRC–recommendations,Simplenumerical. 2.6 Curves:Necessity,types:Horizontal,verticalcurves. 2.7 Extra wideningofroads:numericalexamples. 2.8 Super elevation: Definition, formula for calculating minimum and maximumSuperelevationandmethod of providingsuper-elevation. 2.9 Standardscross-sectionsofnational highwayinembankment andcutting.	12

Unit– 3	**ConstructionofRoadPavements**	
	3.1TypesofroadmaterialsandtheirTests–Testonaggregates-FlakinessandElongation Index tests, Angularity Number test, test on Bitumen-penetration,Ductility,Flash and FirepointtestandSofteningpointtest.	
	3.2 Pavement–Definition, Types, Structural Components of pavementand theirfunctions.	
	3.3 ConstructionofWBMroad. MeritsanddemeritsofWBMroad.	10
	3.4 ConstructionofFlexiblepavement/BituminousRoad,TypesofBitumenanditsproperties.	
	3.5 Cementconcreteroad- methodsofconstruction,AlternateandContinuousBayMethod,Constructionjoints,fillerandsealers,meritsanddemeritsofconcrete roads.Typesofjoints.	
Unit– 4	**BasicsofRailwayEngineering**	
	4.1 ClassificationofIndianRailways,zonesofIndianRailways.	
	4.2 Permanentway:Idealrequirement,Components;RailGauge,types,factorsaffecting selection ofagauge.	
	4.3 Rail,RailJoints-requirements,types.	10
	4.4 Creepofrail:causesandprevention.	
	4.5Sleepers-functionsandRequirement,types-concretesleepers andtheirdensity.	
	4.6 Rail fixturesandfastenings–fishplate,spikes,bolts,keys,bearingplates.	
Unit– 5	**Trackgeometrics,ConstructionandMaintenance**	
	5.1 Alignment-Factorsgoverningrailalignment.	
	5.2 Track Cross sections–standard cross section of single and double line in cuttingandembankment.Importantterms- permanentland,formationwidth,sidedrains.	
	5.3 Railway Track Geometrics: Gradient, curves-types and factors affecting, gradecompensation,superelevation,limitsofSuperelevationoncurves,cantdeficiency,negative cant,coning ofwheel,tilting ofrail.	
	5.4 BranchingofTracks,Pointsandcrossings,Turnout- types,components,functionsandinspection.Trackjunctions:crossovers,scissorcrossover,diamondcrossing, track triangle.	12
	5.5 Station -Purpose, requirement of railway station, important technical terms, typesofrailwaystation,factors affectingsiteselectionforrailwaystation.	
	5.6 Stationyard:Classification–Passenger,goods,locomotiveandmarshalling yards.Function&draw backsofmarshallingyards.	
	Total	48

COURSEOUTCOMES(COs):

1. Identify the types of roads as per IRC recommendations.

2. Implement the geometrical design features of different highways.

3. Perform different tests on road materials.

4. Identify the components of railway track.

5. Identify the defects in railway track

CO PO MAPPING

Co Number	CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C2015405.01	Identify the types of roads as per IRC recommendations.	3	3	-	-	-	-	1
C2015405.02	Implement the geometrical design features of different highways	3	-	3	-	-	-	-
C2015405.03	Perform different tests on road materials.	3	-	-	3	-	-	-
C2015405.04	Identify the components of railway track.	3	2	-	-	-	-	-
C2015405.05	Identify the defects in railway track	3	2	-	-	2	-	1
Average		3	2.33	3	3	2		1

SuggestedTextBook:

1. L.R.Kadiyali,Transportation Engineering,KhannaBookPublishingCo.,Delhi

2.   KhannaS.K.Justo,CEGandVeeraragavan,A,Highway Engineering,Nem ChandandBrothers,Roorkee.

3. Arora,N.L.TransportationEngineering,KhannaPublishers,Delhi.

4. SaxenaSCandAroraSP,AText bookof RailwayEngineering, DhanpatRai Publication.

5. Birdi,Ahuja,Road,Railways, BridgeandTunnelEng.,StandardBookHouse,NewDelhi.

6. Sharma,S.K.,Principles,PracticeandDesignofHighwayEngineering,S.ChandPublication, NewDelhi

7. SwetaKumari,TransportationEngineering, FPH

HYDRAULICS LAB

SubjectCode 2015406	Practical						Credits
	No.of Periods PerWeek			FullMarks	:	50	01
	L	T	P/S		:		
	—	—	02	Internal(PA)	:	15	
	-	-	-	External(ESE)	:	35	

CourseObjective:

- Tounderstandparametersassociatedwithfluidflowandhydrostaticpressure.
- Toknow headlossandwater hammer influidflowingthrough pipes.
- To learndifferenttypesofpumps andtheiruses.

Contents:Practical

Performanyeightexperiments

1. Use piezometertomeasurepressureatagivenpoint.

2. Use Bourdon'sGaugetomeasurepressureatagiven point.

3. UseUtubedifferentialmanometertomeasurepressuredifferencebetweentwogivenpoints.

4. Use Bernoulli's apparatus to apply Bernoulli's theorem to get total energy line for a flow in a closed conduit ofvaryingcross sections.

5. UseReynold'sapparatusto determinetypeofflow.

6. UseFrictionfactorApparatustodeterminefrictionfactorforagivenpipe.

7. Determineminorlossesinpipefittingsdueto suddencontraction andsudden enlargement.

8. DeterminethecoefficientofdischargeforagivenVenturi meter.

9. Determinethehydrauliccoefficientsforsharpedgeorifice.

10. UseCurrentmeterto measurethevelocityof flowofwaterinopenchannel.

11. UsePitottubetomeasurethevelocity offlowofwater in openchannel.

12. Usetriangular notch tomeasurethedischargethroughopenchannel.

13. UseRectangularnotchtomeasurethedischargethroughopenchannel.

14. DeterminetheManning'sconstant orChezy'sconstantforgivenrectangularchannel section.

15. Study&useofwatermeter.

16. Studyofamodel of centrifugalandreciprocatingpump.

PracticalOutcomes:

- Measurepressureanddeterminetotalhydrostaticpressurefordifferentconditions.
- Understandvarious parametersassociated withfluidflow.
- Determine headlossoffluidflowthrough pipes.
- Findthe fluidflow parameters inopenchannels.
- Selectrelevanthydraulicpumpsfordifferentapplications.

CO PO MAPPING

Co Number	CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
C2015406.01	Measurepressureanddeterminetotalhydrostaticpressurefordifferentconditions.	3	2	2	3	2	-	1
C2015406.02	Understandvarious parametersassociated withfluidflow.	3	2	-	-	-	-	-
C2015406.03	Determine headlossoffluidflowthrough pipes.	3	2	2	3	2	-	1
C2015406.04	Findthe fluidflow parameters inopenchannels.	3	2		3	1	-	-
C2015406.05	Selectrelevanthydraulicpumpsfordifferentapplications.	3	2	2	3	2	-	2
Average		3	2	2	3	1.75	-	1

SuggestedTextBook:-

1. HydraulicsLaboratory,Rao&Hasan,NewHeightPublication

2. GhoshandTalapohia-Experimental Hydraulic-KhannaPublishers-NewDelhi

3. HydraulicLabManualCompiled-T.T.T.I.-Chennai–113

ADVANCESURVEYINGLAB

SubjectCode **2015407**	Practical						Credits
	No.of Periods PerWeek			FullMarks	:	50	01
	L	T	P/S		:		
	—	—	02	Internal(PA)	:	15	
	-	-	-	External(ESE)	:	35	

Course Objective:

- Toknowmethodsof planesurveying,Theodolite surveyingandtheiruses.
- Tolearntacheometricsurveyingandcurvesetting.
- Tounderstandthe principlesofElectronicDistanceMeasurementandTotalstation andtheiruses.
- Toknow theconceptofRemoteSensing, GPSand GIS.

Contents:Practical

Performanyeightexperiments:

1. Useplanetable surveyto prepareplansofaplotofsevensidedclosedtraversebyRadiationMethod.

2. Useplanetable survey to prepareplans,locatedetailsbyIntersectionMethod.

3. Useplanetablesurvey toprepareplans,locatedetailsbyTraversingMethod.
4. Use plane table survey to carry out Survey Project for closed traverse for minimum five sides aroundabuilding.
5. Usetransit theodolitetomeasureHorizontalandVertical anglebyDirectMethod.
6. Plot the traverse on A1 size imperial drawing sheet for the collected data from preceding Theodolite SurveyProject.
7. UseTheodoliteasaTacheometer tocomputereducedlevelsandhorizontaldistances.

8. Set outacircular curvebyRankine'sMethodofDeflection Angles.
9. UsemicroopticTheodolitetoMeasure HorizontalanglebyDirectMethod.
10. UseEDMtomeasure horizontal distance.
11. UseTotalstationinstrumenttomeasurehorizontaldistances.
12. Use Totalstationinstrument tomeasurevertical angle.
13. UseTotalstationinstrumenttocarry outSurveyProject forclosedtraverseforminimum fivesides.
14. Plot the traverse on A1 size imperial drawing sheet for the collected data from preceding Total StationSurveyProject.
15. UseGPSto locate the coordinatesofastation.

PracticalOutcomes:

- PrepareplansusingPlaneTableSurveys.
- PrepareplansusingTheodolitesurveys.
- FinddistancesandelevationsusingTacheometer.
- MakemeasurementsusingTotalStation.
- LocatecoordinatesofsurveystationsusingGPS

CO PO MAPPING

Co Number	CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C2015407.01	PrepareplansusingPlaneTableSurveys.	3	-	-	1	-	2	2
C2015407.02	PrepareplansusingTheodolitesurveys.	3	-	-	1	-	2	2
C2015407.03	FinddistancesandelevationsusingTacheometer.	3	2	1	-	-	1	-
C2015407.04	MakemeasurementsusingTotalStation.	-	2	1	-	1	-	-

C2015407.05	Locatecoordinatesofsurveystations usingGPS	3	-	-	2	-	1	1
Average		3	2	1	1.33	1	1.5	1.66

ReferenceBook :

1. Kanetkar,T.P.;Kulkarni,S.V., SurveyingandLevellingPart IandII, PuneVidyarthiGruhPrakashan,Pune.
2. Basak,N.N.,SurveyingandLevelling,McGrawHillEducation(India)Pvt.Ltd.,Noida.
3. Duggal,S.K.,SurveyIandSurveyII,TataMcGraw HillEducationPvt.Ltd.,Noida.
4. Saikia,MD.;Das.B.M.;Das. M.M.,Surveying PHILearningPvt.Ltd., NewDelhi.
5. Subramanian,R.,SurveyingandLevelling,OxfordUniversityPress.NewDelhi.

THEORYOFSTRUCTURE LAB(TW)

SubjectCode 2015408	Practical						Credits
	No.ofPeriods PerWeek			FullMarks	:	25	
	L	T	P/S	Internal	:	07	02
	—	—	04	External	:	18	
	-	-	-		:		

CourseObjective:
1. Tounderstandandanalyzestress&strain,shearforce&bending moment.
2. Tostudybehaviorofcolumn.
3. Tolearnhingeaction.
4. Toanalyzedeflectionofbeams

Contents:Practical

1. ToVerifyStraininanexternallyloadedbeamwiththehelpofastraingaugeindicator

   andtoverifytheoretically.

2. TostudybehaviorofdifferenttypesofColumns:(i)Bothendsfixed(ii)OneendfixedandotherPinned(iii)Bothendspinned(iv)Oneendfixedandotherfree.

3. TofindEuler'sbucklingloadfordifferenttypesofColumns:(i)Bothendsfixed(ii)Oneendfixedandotherpinned.(ii) Bothendspinned (iv)Oneendfixedandotherfree.

4. ToStudytwohingedarchforthehorizontal displacementoftherollerendforagivensystemofloadingandtocomparethesamewiththoseobtainedanalytically.

5. DeterminationofShearforceandbendingmomentofbeam.

6. Compressiontestonmetal.

7. Determinationofdeflectionofbeam.

8. Determinationofmoment ofInertiaofflywheel.

PracticalOutcomes:
1. Interpretshearforce&bendingmoment.
2. Interpretbucklingofcolumn.
3. Interprettheresultofhingeaction.

CO PO MAPPING

Co Number	CO Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7
C2015408.01	Interpretshearforce&bendingmoment.	2	_	3	3	2	_	_
C2015408.02	Interpretbucklingofcolumn.	2	3	3	2	_	_	_
C2015408.03	Interprettheresultofhingeaction.	2	3	3	2	_	_	1
Average		2	3	3	2.33	2		1

TextBook/ReferenceBook:
1. Theoryofstructures,S.Ramamrutham,Dhanpatrai&Sons.
2. Mechanicsofstructures,S.B.Junnarkar,CharotarpublishingHouse,Anand

BUILDING PLANNING AND DRAWING (TW)

SubjectCode 2015409	Practical						Credits
	No.of Periods PerWeek			FullMarks	:	50	02
	L	T	P/S	Internal(PA)	:	15	
	—	—	04	External(ESE)	:	35	
	-	-	-	_	:	_	

CourseObjectives:

- Tolearnthebasicprinciplesofbuildingplanninganddrawing.
- Tomakegraphicalrepresentationofvariouscomponentsofbuildings.
- Todrawcompleteplanandelevationofabuilding.
- Tolearnbasicsofperspectivedrawingsand ComputerAidedDrawings.

Contents:-TermWork

1. Drawvarioustypesoflines,graphicalsymbolsformaterials,doorsandwindows,symbolsforsanitary,watersupplyandelectricalinstallationsandwriteabbreviationsasperIS962.

2. Drawlineplanofanexistingbuildingtothesuitablescale.

3. Draw line plans to suitable scale for any one Public Buildings from the following (School Building, Primary HealthCentre,Hostel and Library).

4. Drawsubmissiondrawingtothescale1:100ofasinglestoreyloadbearingresidential building(2BHK)withflatroofandstaircaseshowing:

   (a) Developedplanandelevation

   (b) Foundationplan

   (c) Siteplan(1:200),areastatement

5. Drawsubmissiondrawingtothescaleof1:100of(G+1)FramedStructureResidentialBuilding(2BHK)withflatroofand staircaseshowing:

   a) Developedplan.

   b) Elevation.

   c) Siteplan(1:200)andareastatement.

6. Drawtheabovementioneddrawingatserialnumber05usingCADsoftwareandenclosetheprintout.
   a) Developedplan.
   b) Elevation.
   c) SectionpassingthroughStaircase.
   d) Foundationplan.
   e) Siteplan(1:200),areastatement.

7. Drawworkingdrawingforabovementioneddrawingatserialnumber05showing:
   a) Foundationplantothescale1:50
   b) DetailedenlargedsectionofRCCcolumnandfootingwithplinthfilling.
   c) DetailedenlargedsectionofRCCBeam,LintelandChajjas.
   d) DetailedenlargedsectionofRCCstaircaseandslab.

8. Drawtwopointperspectivesdrawingofsmallobjects-steps,monuments,pedestals(anyone)scale1:50
   a) Drawplan,elevation,eyelevel,pictureplaneandvanishingpoints

   b) Drawperspectiveview.

Practical outcomes:

- Interpret the symbols, signs and conventions from the given drawing.
- Prepare line plans of residential and public buildings using principles of planning.
- Prepare working drawing for the given requirement of Load Bearing Structure.
- Prepare working drawing using CAD for the given requirement of Framed Structure.
- Draw two-point perspective drawing for given small objects.

CO PO MAPPING

Co Number	CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
C2015409. 01	Interpret the symbols, signs and conventions from the given drawing.	3	–	–	–	–	–	1
C2015409. 02	Prepare line plans of residential and public buildings using principles of planning	–	3	–	–	2	–	–
C2015409. 03	Prepare working drawing for the given requirement of Load Bearing Structure	–	3	–	–	–	2	1
C2015409. 04	Prepare working drawing using CAD for the given requirement of Framed Structure	–	3	–	2	–	–	–
C2015409. 05	Draw two-point perspective drawing for given small objects.	3	–	2	–	–	–	–
Average		3	3	2	2	2	2	1

SuggestedTextBook/RefrenceBook:-

1. Shah.M.G.Kale,CM,Patki,S.Y.,BuildingDrawing,McgrawHillPublishing
2. MalikandMayo,CivilEngineeringDrawing,ComputechPublicationLtd
3. M.G.ShahandC.M.Kale,PrinciplesofPerspectiveDrawing,McgrawHill
4. Swamy,Kumara;Rao,N,Kameshwara,A.,BuildingPlanningandDrawing,CharotarPublication,Anand.
5. Bhavikatti,S.S.,BuildingConstruction,VikasPublicationHousePvt.Ltd.,Delhi.
6. Mantri,Sandip,AtoZBuildingConstruction,SatyaPrakashan,NewDelhi.
7. Singh,Ajit,WorkingwithAutoCAD2000,McgrawHillPublishingcompanyLtd.
8. Sane,Y.S.,PlanninganddesignofBuilding,AlliedPublishers,NewDelhi.

TRANSPORTATIONENGINEERING (TW)

SubjectCode 2015410	TermWork						Credits
	No.of Periods PerWeek			FullMarks	:	25	01
	L	T	P/S	Internal(PA)	:	07	
	—	—	02	External(ESE)	:	18	

CourseObjective:
1. ToidentifythetypesofroadsasperIRCrecommendations.
2. Tounderstandthegeometricaldesignfeaturesofdifferenthighways.
3. Toperform differenttestsonroadmaterials.
4. Toidentifythecomponentsofrailwaytracks.

CONTENTS:-TERMWORK

PerformanyeightExperiments/ Study
1. DrawthesketchesshowingstandardcrosssectionsofExpressways,NH,SH,MDR,ODR.
2. FlakinessandElongationIndexofaggregates.
3. AngularityNumberofaggregates.
4. Aggregateimpacttest.
5. LosAngelesAbrasiontest.
6. Aggregatecrushingtest.
7. Penetrationtestofbitumen.
8. Softeningpointtestofbitumen.
9. DuctilitytestofBitumen.
10. Visittheroadofanyonetype(flexibleorrigid)toknowthedrainagecondition.
11. Visittorailwaytrackforvisualinsectionoffixtures,fastenersandyards.

PracticalOutcomes:
1. IdentifythetypesofroadsasperIRCrecommendations.
2. Implementthegeometricaldesignfeaturesofdifferenthighways.
3. Performdifferenttestsonroadmaterials.
4. Identifythecomponentsofrailwaytrack.
5. Identifythedefectsinrailwaytrack

CO PO MAPPING

Co Number	CO Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
C2015410.01	IdentifythetypesofroadsasperIRCrecommendations.	3	2	–	–	-	–	1
C2015410.02	Implementthegeometricaldesignfeaturesofdifferenthighways.	–	3	–	–	2	–	1
C2015410.03	Performdifferenttestsonroadmaterials.	–	–	3	3	2	–	–
C2015410.04	Identifythecomponentsofrailwaytrack.	3	–	1	–	-	–	–
C2015410.05	Identifythedefectsinrailwaytrack	–	3	–	–	2	1	1
Average		3	2.66	2	1.5	2	1	1

Reference Book:

1. L.R.Kadiyali,TransportationEngineering,KhannaBookPublishingCo.,NewDelhi
2. KhannaS.K.,Justo,CEGandVeeraragavan,A.,HighwayEngineering, NemChandandBrothers,Roorkee.
3. Arora,N.L.TransportationEngineering,KhannaPublishers,Delhi.
4. SaxenaSCandAroraSP,AText bookofRailwayEngineering, DhanpatRai Publication.
5. Birdi,Ahuja,Road,Railways,BridgeandTunnelEng.,StandardBookHouse,Delhi.
6. Sharma,S.K.,Principles, PracticeandDesignof HighwayEngineering,S.Chand
7. Duggal,AjayK.andPuri,V.P.,LaboratoryManualinHighway Engineering,NewAgeInternational (P)Limited,Publishers,NewDelhi.
8. Subramanian,K.P.,Highway,Railway,AirportandHarborsEngineering,SciTechPublications,Hyderabad

TERMWORK
COURSEAUTOCAD/STAAD.PRO/OTHERS(TW)

SubjectCode 2015411	TermWork						Credits
	No.of Periods PerWeek			FullMarks	:	50	02
	L	T	P/S	Internal(PA)	:	15	
	—	—	04	External(ESE)	:	35	

STATE BOARD OF TECHNICAL EDUCATION, BIHAR

Scheme of Teaching and Examinations for
Vth SEMESTER DIPLOMA IN CIVIL ENGINEERING / CIVIL (RURAL) ENGINEERING
(Effective from Session 2020-21 Batch)

THEORY

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME Periods per Week	EXAMINATION-SCHEME								
				Hours of Exam.	Teacher's Assessment (TA) Marks A	Class Test (CT) Marks B	End Semester Exam. (ESE) Marks C	Total Marks (A+B+C)	Pass Maks ESE	Pass Marks in the Subject	Credits
1.	Design of steel and R.C.C Structure	2015501	03	03	10	20	70	100	28	40	03
2.	Estimating and Costing	2015502	03	04	10	20	70	100	28	40	03
3.	Water Resources Engineering.	2015503	03	03	10	20	70	100	28	40	03
4.	Program Elective-I	2015504	03	03	10	20	70	100	28	40	03
	Precast and Prestressed Concrete (2015504A)		Construction Management (2015504B)				Rural Construction Technology (2015504C)				
5.	Open Elective / COE		02	03	10	20	70	100	28	40	02
	Traffic Engineering (2015505A)		Solid Waste Management (2015505B)				Advanced Construction Technology (2015505C)				
	Artificial Intelligence (Basics) (2000505B)		Internet of Things (Basics) (2000505C)				Drone Technology (Basics) (2000505D)				
	3D Printing & Design (Basics) (2000505E)		Industrial Automation (Basics) (2000505F)			Electric Vehicles (Basics) (2000505G)			Robotics (Basics) (2000505H)		
		Total :-	14				350	500			14

PRACTICAL

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME Periods per Week	EXAMINATION-SCHEME					
				Hours of Exam.	Practical (ESE) Internal (PA)	Practical (ESE) External (ESE)	Total Marks	Pass Marks in the Subject	Credits
6.	Estimating & Costing Lab	2015506	04 50% Physical 50% Virtual	04	15	35	50	20	02
7.	Elective Lab / COE Lab		04 50% Physical 50% Virtual	03	20	30	50	20	02
	Design of steel and RCC structure Lab (2015508 A)		Artificial Intelligence Lab (Basics) (2000508B)				Internet of Things Lab (Basics) (2000508C)		
	Drone Technology Lab (Basics) (2000508D)		3D Printing & Design Lab (Basics) (2000508E)						
	Industrial Automation Lab (Basics) (2000508F)		Electric Vehicles Lab (Basics) (2000508G)				Robotics Lab (Basics) (2000508H)		
	Total :- 08						100		04

TERM WORK

Sr. No.	SUBJECT	SUBJECT CODE	TEACHING SCHEME Periods per Week	EXAMINATION-SCHEME				
				Marks of Internal (PA)	Marks of External (ESE)	Total Marks	Pass Marks in the Subject	Credits
8.	In- Plant training	2015509	Four Weeks.	15	35	50	20	02
9.	Minor Project	2015510	04	07	18	25	10	02
10.	Term Work		02	20	30	50	20	01
	Course under Moocs/ NPTEL / Others (2015511)		Artificial Intelligence (Basics) (TW) (2000511 B)	Internet of Things (Basics) (TW) (2000511 C)		Drone Technology (Basics) (TW) (2000511D)		
	3D Printing (Basics) (TW) (2000511E)		Industrial Automation (Basics) (TW) (2000511F)	Electric Vehicles (Basics) (TW) (2000511G)		Robotics (Basics) (TW) (2000511H)		
11	Course Primavera/3D Max / Others	2015512	02	07	18	25	10	01
	Total:-		08			150		06
	Total Periods Per week each of duration one hour = 30			Total Marks = 750				24

Design of steel and R.C.C Structure

Subject Code	Theory						Credits
2015501	**No. of Periods Per Week**			**Full Marks**	**:**	**100**	**03**
	L	**T**	**P/S**	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objectives:

Following are the objectives of this course:
• To learn the concept of limit state design for tension and compression steel members.
• To learn the concept of limit state design of steel beams.
• To understand design of RCC elements.
• To know the design of short and long RCC columns.

CONTENTS: THEORY

Name of the Topic	Hrs
Unit -1 **Design of Steel Tension and Compression Members (Limit State Method)**	
1.1 Types of sections used for Tension members and Compression members.	
1.2 Strength of tension member by yielding of section, rupture of net cross-section and block shear.	
1.3 Calculation of effective length, Radius of gyration and slenderness ratio, Permissible values of slenderness ratio as per IS 800, Calculation of Design compressive stress.	
1.4 Introduction to built up sections, lacing and battening (Meaning and purpose), Diagrams of single and double lacing and battening system. (No numerical problems).	14
Unit -2 **Design of Steel beams (Limit State Method)**	
2.1 Standard beam sections, Bending stress calculations.	
2.2 Design of simple I and channel section.	06
2.3 Check for shear as per IS 800.	
Unit – 3 **Design of Reinforced Concrete Beams by Limit State Method**	
3.1 Concept of Limit state, Stress block diagram, Introduction to singly and doubly reinforced sections as per IS 456.	
3.2 Design of singly reinforced beam, concept of under reinforced, over reinforced and balanced section, Simple numerical problem on ultimate moment of resistance and design of beam section.	
3.3 Design of doubly reinforced sections, stress and strain diagrams, depth of neutral axis, simple numerical problems on ultimate moment of resistance of reinforced beam, Calculation of Ast and Asc.	14
Unit – 4 **Shear, Bond and Development length in Design of RCC member**	
4.1 Nominal shear stress in RCC section, Design shear strength of concrete, Design of shear reinforcement, Minimum Shear Reinforcement, Provisions of IS 456, forms of shear reinforcement.	
4.2 Types of bonds, Bond stress, check for bond stress, Determination of Development length in tension and compression members and check as per codal provisions, Anchorage value of 90-degree hook, Lapping of bars.	
4.3 Simple numerical on: Shear reinforcement, Adequacy of section for shear.	
4.4 Introduction to serviceability limit state check.	08
Unit – 5 **Design of axially loaded RCC Column**	
5.1 Definition and classification of column, Limit state of compression members, Effective length of column.	
5.2 Provisions of IS 456 for minimum steel, cover, maximum steel, spacing of ties etc.	
5.3 Design of axially loaded short column - Square, Rectangular, and Circular only.	06
Total	48

References:

Titles of the Book	Name of Authors	Name of the Publisher
Design of Steel Structures	Subramanian N	Oxford University Press
Design of Steel and R.C.C. Structure	S.N.P. Srivastava	FPH (Foundation Publishing House)
Design of Steel and R.C.C. Structure	S.S. Joshi	FPH (Foundation Publishing House)
Reinforced Concrete Design Principles and Practice	Krishna Raju, and N. Pranesh, R.N.	New Age International, Mumbai.
Fundamentals of Reinforced Concrete	N.C Sinha & S.K Roy	S. Chand & Co., New Delhi
Reinforced concrete Design	S.U Pillai and Menon, Devdas	McGraw Hill Publications, New Delhi

Course outcomes:

After completing this course, student will be able to perform:

   CO 1 : Design of steel tension and compression member.
   CO 2 : Design of steel beams including check for shear.
   CO 3 : Design of singly and doubly reinforced RCC beam.
   CO 4 : Design of shear reinforcement in RCC beams.
   CO 5 : Design of RCC column as per IS 456.

ESTIMATING AND COSTING

Subject Code	Theory						Credits
2015502	**No. of Periods Per Week**			**Full Marks**	**:**	**100**	**03**
	L	**T**	**P/S**	**ESE**	**:**	**70**	
	03	**—**	**—**	**TA**	**:**	**10**	
	—	**—**	**—**	**CT**	**:**	**20**	

Course Objectives:

Following are the objectives of this course:
• To learn the procedure for estimating and costing of Civil Engineering works.
• To perform rate analysis for different items associated with construction projects.
• To prepare detailed estimate related to Civil Engineering Works.

CONTENTS: THEORY

	Name of the Topic	Hrs
Unit -1	**Fundamentals of Estimating and Costing:** **1.1** Estimating and Costing – Meaning, purpose, Administrative approval, Technical Sanction and Budget provision. **1.2** Types of estimates – Approximate and Detailed estimate. **1.3** Types and Uses of Estimates: Revised estimate, Supplementary estimate, Repair and maintenance estimate, renovation estimate. **1.4** Roles and responsibility of Estimator. **1.5** Checklist of items in load bearing and framed structure. **1.6** Standard formats of Measurement sheet, Abstract sheet, Face sheet. **1.7** Modes of measurement and desired accuracy in measurements for different items of work as per IS:1200. **1.8** Rules for deduction in different category of work as per IS:1200	10
Unit -2	**Approximate Estimates:** **2.1** Approximate estimate- Definition, Purpose. **2.2** Methods of approximate estimate - Service unit method, Plinth area rate method, Cubical content method, Typical bay method, Approximate quantity method (with simple numerical) **2.3** Approximate estimate for roads and water supply projects.	08
Unit – 3	**Detailed Estimate:** **3.1** Detailed Estimate- Definition and Purpose, Data required for detailed estimate - Civil cost, GST, Supervision charges, Agency charges, Procedure for preparation of detailed estimate- Taking out quantities and Abstracting. **3.2** Methods of Detailed Estimate- Unit quantity method and total quantity method (with simple numerical) **3.3** Long wall and short wall method, Centre line method. **3.4** Bar bending schedule for footing, column, beam, Lintel, chajja and slab elements. **3.5** Provisions in detailed estimate: contingencies, work charged establishment, percentage charges, water supply and sanitary Charges and electrification charges. **3.6** Prime cost, Provisional sum, Provisional quantities, Bill of quantities, Spot items or Site items.	12
Unit – 4	**Estimate for Civil Engineering Works:** **4.1** Earthwork - Quantities for roads, Embankment and canal by – Mid sectional area method, mean sectional area method, Prismoidal and trapezoidal formula method. **4.2** Detailed estimate for septic tank.	08
Unit – 5	**Rate Analysis:** **5.1** Rate Analysis: Definition, purpose and importance. **5.2** Lead (Standard and Extra), lift, overhead charges, water charges and contractor's profit. **5.3** Procedure for rate analysis. **5.4** Task work- Definition, types. Task work of different skilled labour for different items. **5.5** Categories of labours, their daily wages, types and number of labours for different items of work. **5.6** Preparing rate analysis of different items of work pertaining to buildings.	10
	Total	48

Text/ Reference Books:-		
Titles of the Book	Name of Authors	Name of the Publisher
Estimating and Costing in Civil engineering	B.N Dutta	UBS Publishers Distributors Pvt. Ltd. New Delhi
Estimating and costing	R.S. Majumdar	FPH (Foundation Publishing House)
Estimating and costing	Arun Kumar Gupta	FPH (Foundation Publishing House)
Estimating and Costing	S.C Rangwala	Charotar Publishing House PVT. LTD., Anand.
Estimating and costing, specification and valuation in civil engineering	M. Chakraborti,	Monojit Chakraborti, Kolkata.
Estimating construction cost (fifth edition)	L. Peurifoy,Robert Oberlender,Garold	Mc Graw Hill Education, , New Delhi.

Course outcomes:

After completing this course, student will be able to:

CO 1 : Select modes of measurements for different items of works.

CO 2 : Prepare approximate estimate of civil engineering works.

CO 3 : Prepare detailed estimate of civil engineering works.

CO 4 : Justify rate for given items of work using rate analysis techniques.

WATER RESOURCES ENGINEERING

Subject Code	Theory						Credits
2015503	**No. of Periods Per Week**			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objectives:

Following are the objectives of this course:
• To learn estimation of hydrological parameters.
• To understand water demand of crops and provisions to meet the same.
• To know planning of reservoirs and dams.
 • To design irrigation projects, canals and other diversion works.

CONTENTS: THEORY

	Name of the Topic	Hrs
Unit -1	**Introduction to Hydrology** 1.1 Hydrology: Definition and Hydrological cycle. 1.2 Rain Gauge: Symon's rain gauge, automatic rain gauge. 1.3 Methods of calculating average rainfall: Arithmetic mean, Isohyetal, and Theissen polygon method. 1.4 Runoff, Factors affecting Run off, Computation of run off. 1.5 Maximum Flood Discharge measurement: Rational and empirical methods, Simple numerical problems.	06
Unit -2	**Crop water requirement** 2.1 Irrigation and its classification. 2.2 Crop Water requirement: Cropping seasons, Crop period, base period, Duty, Delta, CCA, GCA, intensity of irrigation, factors affecting duty, Problems on water requirement and capacity of canal. 2.3 Methods of application of irrigation water and its assessment. 2.4 Area capacity curve.	08
Unit – 3	**Dams and Spillways** 3.1 Dams and its classification: Earthen dams and Gravity dams (masonry and concrete). 3.2 Earthen Dams – Components with function, typical cross section, seepage through embankment and foundation and its control. 3.3 Methods of construction of earthen dam, types of failure of earthen dam and preventive measures. 3.4 Gravity Dams – Forces acting on dam, Theoretical and practical profile, typical cross section, drainage gallery, joints in gravity dam, concept of high dam and low dam. 3.5 Spillways-Definition, function, location, types and components, Energy dissipaters.	12
Unit – 4	**Minor and Micro Irrigation** 4.1 Bandhara irrigation: Layout, components, construction and working, solid and open bandhara. 4.2 Percolation Tanks – Need, selection of site. 4.3 Lift irrigation Scheme-Components and their functions, Lay out. 4.4 Drip and Sprinkler Irrigation- Need, components and Layout. 4.5 Well irrigation: types and yield of wells, advantages and disadvantages of well irrigation	08
Unit – 5	**Diversion Head Works & Canals** 5.1 Weirs – components, parts, types, 5.2 Diversion head works – Layout, components and their function. 5.3 Barrages – components and their functions. Difference between weir and Barrage. 5.4 Canals – Classification according to alignment and position in the canal network, Cross section of canal in embankment and cutting, partial embankment and cutting, balancing depth, Design of most economical canal section. 5.5 Canal lining - Purpose, material used and its properties, advantages. Cross Drainage works-Aqueduct, siphon aqueduct, super passage, level crossing. 5.6 Canal regulators- Head regulator, Cross regulator, Escape, Falls and Outlets.	14
	Total	48

Text / Reference Books:-

Titles of the Book	Name of Authors	Name of the Publisher
Irrigation and Water Power Engineering	B.C Punmia B. Pande, B Lal	Laxmi Publications
Engineering Hydrology	K. Subramanya	McGraw Hill Education
Applied Hydrology	K.N Mutreja	McGraw Hill Education
Water Resources Engineering	Piyush Goyal	FPH (Foundation Publishing House)
Irrigation Engineering	N.N Basak	McGraw Hill Education
Irrigation and Hydraulic Structures	S. K Garg	Khanna Publishers, Delhi.
Irrigation Engineering	R.K Sharma T.K Sharma	S Chand

Course outcomes:

After completing this course, student will be able to:

CO 1 : Estimate hydrological parameters.

CO 2 : Estimate crop water requirements of a command area and capacity of canals.

CO 3 : Execute Minor and Micro Irrigation Schemes.

CO 4 : Select the relevant Cross Drainage works for the specific site conditions.

CO 5 : Design, construct and maintain simple irrigation regulatory structures.

PRECAST AND PRESTRESSED CONCRETE

Subject Code 2015504A	Theory						Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	0 3	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objectives:

Following are the objectives of this course:

• To introduce various types of precast and prefabricated concrete elements.

• To know advantages and disadvantages of precast and prefabricated concrete elements.

• To understand prestressing methods, systems for Reinforced Concrete members.

• To learn issues involved in design of prestressing system and loss of prestressing.

	CONTENTS: THEORY Name of the Topic	Hrs
Unit -1	**Precast concrete Elements** 1.1 Advantages and disadvantages of precast concrete members. 1.2 Non-structural Precast elements - Paver blocks, Fencing Poles, Transmission Poles, Manhole Covers, Hollow and Solid Blocks, kerb stones as per relevant BIS specifications. 1.3 Structural Precast elements – Canal lining, Box culvert, bridge panels, foundation. 1.4 Testing of Precast components as per BIS standards.	06
Unit -2	**Prefabricated building** 2.1 Precast Structural Building components such as slab panels, beams, columns, footings, walls, lintels and chajjas, staircase elements. 2.2 Prefabricated building using precast load bearing and non-load bearing wall panels, floor systems - Material characteristics, Plans & Standard specifications. 2.3 Modular co-ordination, modular grid, and finishes. 2.4 Prefab systems and structural schemes and their classification including design considerations. 2.5 Joints – requirements of structural joints and their design considerations.	08
Unit – 3	**Introduction to Prestressed Concrete** 3.1 Principles of pre-stressed concrete and basic terminology. 3.2 Applications, advantages and disadvantages of prestressed concrete. 3.3 Materials used and their properties, Necessity of high-grade materials. 3.4 Types of Pre-stressing steel -Wire, Cable, tendon, Merits-demerits and applications.	06
Unit – 4	**Methods and systems of prestressing** 4.1 Methods of prestressing – Internal and External pre-stressing, Pre and Post tensioning- applications 4.2 Systems for pre tensioning – process, applications, merits and demerits. 4.3 Systems for post-tensioning - process, applications, merits and demerits 4.4 Prestressing force in Cable, Loss of prestress during the tensioning process - loss due to friction, length effect, wobbling effect and curvature effect, (Simple Numerical problems to determine loss of pre-stress), Loss of pre-stress at the anchoring stage. 4.5 Loss of pre-stress occurring subsequently: losses due to shrinkage of concrete, creep of concrete, elastic shortening, and creep in steel, (Simple Numerical problems to determine loss of pre-stress). 4.6 BIS recommendations for percentage loss in case of Pre and Post tensioning.	14
Unit – 5	**Analysis and design of Prestressed rectangular beam section** 5.1 Basic assumptions in analysis of pre-stressed concrete beams. 5.2 Cable Profile in simply supported rectangular beam section – concentric, eccentric, straight and parabolic. Effect of cable profile on maximum stresses at mid span and at support. 5.3 Numerical problems on determination of maximum stresses at mid spans with linear (concentric and eccentric) cable profiles only. 5.4 Simple steps involved in Design of simply supported rectangular beam section (No numerical problems).	14
	Total	48

Course outcomes:

After completing this course, student will be able to:

Text/ Reference Books: -		
Titles of the Book	Name of Authors	Name of the Publisher
Pre-stressed Concrete	N. Krishna Raju	Tata McGraw Hill, New Delhi
Handbook on Precast Concrete buildings	. Indian Concrete Institute	--
Prestressed Concrete	B. Vanakudre Shrikant	Khanna Publishing House, New Delhi
Precast and Pressurised Concrete	Vikash Sinha	FPH (Foundation Publishing House)
IS 12592 Precast Concrete Manhole Cover and Frame	BIS, New Delhi	BIS, New Delhi
IS 15658 Precast concrete blocks for paving - Code of Practice	BIS, New Delhi	BIS, New Delhi
IS 15916 Building Design and Erection Using Prefabricated Concrete- Code of Practice	BIS, New Delhi	BIS, New Delhi
IS 15917 Building Design and Erection Using Mixed/Composite Construction- Code of Practice	BIS, New Delhi	BIS, New Delhi
IS 458 Precast Concrete Pipes (with and without reinforcement) — Specifications.	BIS, New Delhi	BIS, New Delhi

CO 1 : Select the relevant precast concrete element for a given type of construction.

CO 2 : Use relevant components for prefabricated structures.

CO 3 : Justify the relevance of prestressed element in a given situation.

CO 4 : Select relevant methods / systems for given construction work.

CO 5 : Propose suitable cable profile for the given prestressed concrete members

CONSTRUCTION MANAGEMENT

Subject Code	Theory						Credits
2015504B	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objectives:

Following are the objectives of this course:

• To understand the contract management and associated labour laws.

• To prepare and understand the principals involved in site layout.

• To know the procedure for scheduling of various activities in construction project.

• To understand the labour laws, procedure for arbitration, settlements.

• To know different safety measures in construction projects.

CONTENTS: THEORY

	Name of the Topic	Hrs
Unit -1	**Construction industry and management** 1.1 Organization-objectives, principles of organization, types of organization: government/public and private construction industry, Role of various personnel in construction organization 1.2 Agencies associated with construction work- owner, promoter, builder, designer, architects. 1.3 Role of consultant for various activities: monitoring of progress and quality, settlement of disputes.	10
Unit -2	**Site Layout** 2.1 Principles governing site layout. 2.2 Factors affecting site layout. 2.3 Preparation of site layout. 2.4 Land acquisition procedures and providing compensation.	08
Unit – 3	**Planning and scheduling** 3.1 Identifying broad activities in construction work & allotting time to it, Methods of Scheduling, Development of bar charts, Merits & limitations of bar chart. 3.2 Elements of Network: Event, activity, dummy activities, Precautions in drawing Network, Numbering the events. 3.3 CPM networks, activity time estimate, Event Times by forward & backward pass calculation, start and finish time of activity, project duration. Floats: Types of Floats-Free, independent and total floats, critical activities and critical path, 3.4 Purpose of crashing a network, Normal Time and Cost, Crash Time and Cost, Cost slope, Optimization of cost and duration.	16
Unit – 4	**Construction Contracts and Specifications** 4.1 Types of Construction contracts 4.2 Contract documents, specifications, general special conditions 4.3 Contract Management, procedures involved in arbitration and settlement (Introduction only)	08
Unit – 5	**Safety in Construction** 5.1 Safety in Construction Industry—Causes of Accidents, Remedial and Preventive Measures. 5.2 Labour Laws and Acts pertaining to Civil construction activities (Introduction only)	06
	Total	48

Text/ Reference Books: -		
Titles of the Book	Name of Authors	Name of the Publisher
Construction Engineering and Management	S.C Sharma and Deodhar S. V	Khanna book publishing, New Delhi
Construction planning and management	P.S Gahlot S.V, B.M Dhir	New Age International (P) Ltd. Publishers, New Delhi.
Construction Management	R.L. Arora	FPH (Foundation Publishing House)
Project Planning and Controlling with PERT And CPM,	B.C. Punmia, & K.K Khandelwal,	Laxmi Publications (P)Ltd.

Course outcomes:

After completing this course, student will be able to:

CO 1 : Understand the contract management and associated labour laws.

CO 2 : Prepare and understand the nuances of executing the site layout.

CO 3 : Prepare networks and bar charts for the given construction project.

CO 4 : Understand the intricacies of disputes, related arbitration and settlement laws.

CO 5 : Apply safety measures at construction projects.

RURAL CONSTRUCTION TECHNOLOGY

Subject Code	Theory						Credits
2015504C	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objectives:

Following are the objectives of this course:

• To learn development and planning of low-cost housing infrastructure.

• To know about different government schemes for rural development.

• To understand techniques for rural road construction as per IRC stipulations.

• To learn rural irrigation techniques and watershed management

CONTENTS: THEORY

	Name of the Topic	Hrs
Unit -1	**Rural Development and Planning** 1.1 Scope; development plans; various approaches to rural development planning. 1.2 Significance of rural development. 1.3 Rural development programme/project.	06
Unit -2	**Rural Housing** 2.1 Low-cost construction material for housing. 2.2 Composite material- ferro-cement & fly ash. 2.3 soil-stabilized un-burnt brick; Plinth protection of mud walls. 2.4 Water-proof and fire-retardant roof treatment for thatch roofs. Pre-cast stone masonry, rattrap bond for walls; Panels for roof. 2.5 Biomass - types of fuels such as firewood, agricultural residues, dung cakes. 2.6 Renewable energy and integrated rural energy program - Objectives, Key elements, Implementation, Financial provisions, sources of renewable energy. 2.7 Working of gobar gas and bio gas plants.	10
Unit – 3	**Water Supply and Sanitation for Rural Areas** 3.1 Sources of water: BIS & WHO water standards. 3.2 Quality, Storage and distribution for rural water supply works. 3.3 Hand pumps-types, installation and operation. 3.4 Conservation of water - rainwater harvesting, drainage in rural areas. 3.5 Construction of low-cost latrines: Two pit pour flush water seal, septic tank.	14
Unit – 4	**Low-Cost Rural Roads** 4.1 Broad categories of Pavement Layers, types of Granular Sub-Bases and Bases. 4.2 Guidelines for Surfacing of Rural Road as per relevant IRC codes. 4.3 Pradhan Mantri Gram Sadak Yojna (PMGSY)- Highlights of Scheme.	08
Unit – 5	**Low-Cost Irrigation** 5.1 Design consideration and construction of tube-well, drip & sprinkler irrigation systems. 5.2 Watershed and catchment area development –problems and features of watershed management. 5.3 Watershed management structures - K. T. weir, Gabian Structure, Cement Plug, Contour Bunding, Farm Pond, Bandhara system.	10
	Total	48

Text/ Reference Books: -

Titles of the Book	Name of Authors	Name of the Publisher
Rural Development in India: Past, Present and Future: A Challenge in the Crisis,	Vasant Desai	Himalaya Publishing House, Delhi.
Rural Construction Technology	Rahul Garg	FPH (Foundation Publishing House)
Advances in Building Materials and Construction.	CBRI, Roorkee	
Rural Development Strategy	A.K Rastogi,	Wide Vision, Jaipur.

Course outcomes:

 After completing this course, student will be able to:

CO 1 : Plan low-cost housing using rural materials.

CO 2 : Make use of relevant government schemes for construction of roads and housing.

CO 3 : Use guidelines for rural road construction.

CO 4 : Implement different irrigation systems for rural areas.

CO 5 : Identify the need of watershed management in rural areas.

TRAFFIC ENGINEERING

Subject Code	Theory						Credits
2015505A	No. of Periods Per Week			Full Marks	:	100	02
	L	T	P/S	ESE	:	70	
	02	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objectives:

Following are the objectives of this course:

• To understand the issues involved in traffic flow

• To know and understand the tools for traffic studies.

• To delineate various traffic control measures.

• To understand measures for preventing accidents.

CONTENTS: THEORY

Name of the Topic	Hrs
Unit -1 **Fundamentals of Traffic Engineering** 1.1 Traffic engineering- Definition, objects, scope 1.2 Relationship between speed, volume and density of traffic. 1.3 Road user's characteristics-physical, mental, emotional factors. 1.4 Vehicular characteristics-width, length, height, weight, speed, efficiency of breaks. 1.5 Road characteristics - gradient, curve of a road, design speed, friction between road and tyre surface. 1.6 Reaction time - factors affecting reaction time. PIEV Theory.	10
Unit -2 **Traffic Studies** 2.1 Traffic volume count data- representation and analysis of data. 2.2 Necessity of Origin and Destination study and its methods. 2.3 Speed studies - Spot speed studies and its presentation. 2.4 Need and method of parking study.	08
Unit – 3 **Road Signs and Traffic Markings** 3.1 Traffic control devices –definition, necessity, types. 3.2 Road signs - definition, objects of road signs. 3.3 Classification as per IRC: Mandatory or Regulatory Cautionary or warning, informatory signs, Location of cautionary or warning sign in urban and non-urban areas, Points to be considered while designing and erecting road signs. 3.4 Traffic markings- definition, classification, carriage way, kerb, object marking and reflector markers.	10
Unit – 4 **Traffic Signals and Traffic Islands** 4.1 Traffic signals- Definition, Types, Traffic control signals, pedestrian signals. 4.2 Types of traffic control signals - Fixed time, manually operated, traffic actuated signals and location of signals. 4.3 Traffic islands –Definition, advantages and disadvantages of providing islands. 4.4 Types of traffic islands - rotary or central, channelizing or Refuge Island. 4.5 Road intersections or junctions - Definition, Types of road intersection. 4.6 Intersection at grade- Types, basic requirements of good intersection at grade. 4.7 Grade separated intersection- advantages and disadvantages.	12

Unit – 5	**Road Accident Studies and Arboriculture**	08
	5.1 Road Accidents-Definition, types and causes for collision and non-collision accidents.	
	5.2 Measures to prevent road accidents.	
	5.3 Collision and condition diagram.	
	5.4 Street lighting definition, necessity, types-luminaire, foot candle, lumen, factors affecting their utilization.	
	5.5 Arboriculture- definition, objectives, factors affecting selection of type of trees.	
	Total	48

Text/ Reference Books: -

Titles of the Book	Name of Authors	Name of the Publisher
Traffic Engineering	Ramesh Singh	FPH (Foundation Publishing House)
Transportation Engineering	L.R Kadiyali	Khanna Book Publishing Co., Delhi
Transportation Engineering Vol. I & II .	V N Vaziani & S P Chaondola,	Khanna Publishers. Delhi.
Traffic planning and design	S C Saxena,	Dhan pat Rai & Sons Delhi.

Course outcomes:

After completing this course, student will be able to:

CO 1 : Analyse road traffic characteristics.

CO 2 : Undertake various types of road traffic studies.

CO 3 : Use relevant road traffic signs, signal and markings.

CO 4 : Identify the intersection depending on the traffic flow.

CO 5 : Suggest preventive measures to avoid accidents by analyzing the traffic conditions at site.

SOLID WASTE MANAGEMENT

Subject Code	Theory				Credits
(2015505B)	No. of Periods Per Week			Full Marks : 100	02
	L	T	P/S	ESE : 70	
	02	—	—	TA : 10	
	—	—	—	CT : 20	

Course Objectives:

Following are the objectives of this course:

• To know various sources of solid waste.

• To learn techniques of collection and transportation of solid waste.

• To know various methods of disposal of solid waste.

• To understand and identify different biomedical and E-waste and their subsequent disposal techniques..

CONTENTS: THEORY

	Name of the Topic	Hrs
Unit -1	**Introduction** 1.1 Definition of solid waste, different solid waste – domestic Waste, commercial waste, industrial waste, market waste, agricultural waste, biomedical waste, E-waste, hazardous waste, institutional waste. 1.2 Sources of solid waste, Classification of solid waste – hazardous and non- hazardous waste. 1.3 Physical and chemical characteristics of municipal solid waste.	10
Unit -2	**Storage, Collection and Transportation of Municipal Solid Waste** 2.1 Collection, segregation, storage and transportation of solid waste. 2.2 Tools and Equipment-Litter Bin, Broom, Shovels, Handcarts, Mechanical road sweepers, Community bin - like movable and stationary bin. 2.3 Transportation vehicles with their working capacity -Animal carts, Auto vehicles, Tractors or Trailers, Trucks, Dumpers, Compactor vehicles. Transfer station- meaning, necessity, location. 2.4 Role of rag pickers and their utility for society.	12
Unit – 3	**Composting of Solid Waste** 3.1 Concept of composting of waste, Principles of composting process. Factors affecting the composting process. 3.2 Methods of composting – Manual Composting – Bangalore method, Indore Method, Mechanical Composting – Dano Process, Vermi composting.	08
Unit – 4	**Techniques for Disposal of Solid Waste** 4.1 Solid waste management techniques – solid waste management hierarchy, waste prevention and waste reduction techniques. 4.2 Land filling technique, Factors to be considered for site selection, Land filling methods-Area method, Trench method and Ramp method, Leachate and its control, Biogas from landfill, Advantages and disadvantages of landfill method. 4.3 Incineration of waste: Introduction of incineration process, Types of incinerators - Flash, Multiple chamber Incinerators, Products of incineration process with their use.	10
Unit – 5	**Biomedical and E-waste management** 5.1 Definition of Bio medical Waste. 5.2 Sources and generation of Biomedical Waste and its classification. 5.3 Bio medical waste Management technologies. 5.4 Definition, varieties and ill effects of E- waste, 5.5 Recycling and disposal of E- waste.	08
	Total	48

Text/ Reference Books:-

Titles of the Book	Name of Authors	Name of the Publisher
Elements of Solid Hazardous Waste Management	O.P Gupta	Khanna Book Publishing Co. Delhi Ed. 2018
Solid Waste Management	D.S. Chandola	FPH (Foundation Publishing House)
Solid Waste Management	A. D , Bhide	Indian National Scientific Documentation Centre, New Delhi.
Solid Waste Management	K Sasikumar	PHI learning, Delhi

Course Outcomes:

CO 1 : Identify the sources of solid waste.

CO 2 : Select the relevant method of collection and transportation of solid waste.

CO 3 : Devise suitable disposal technique for solid waste.

CO 4 : Suggest action plan for composting of solid waste.

CO 5 : Use the relevant method for disposal of Bio-medical and E-waste.

Advanced Construction Technology

Subject Code	Theory						Credits
(2015505C)	No. of Periods Per Week			Full Marks	:	100	02
	L	T	P/S	ESE	:	70	
	02	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Objectives:

Following are the objectives of this course:

• To gain knowledge on different materials in advanced construction

• To know different methods in concreting.

• To know the relevance of advanced construction methods for particular site condition.

• To identify the requisite hoisting and conveying machinery for the given situation.

CONTENTS: TERM WORK

Name of the Topic		Hrs
Unit -1	**Advanced Construction Materials** 1.1 Fibres: Use and properties of steel, polypropylene, carbon and glass fibres. 1.2 Plastics: Use and properties of PVC, RPVC, HDPE, FRP, GRP. 1.3 Miscellaneous Materials: Properties and uses of acoustics materials, waterproofing materials and adhesives.	08
Unit -2	**Advanced Concreting Methods and Equipment's** 2.1 Ready Mix Concrete: Necessity and use of ready-mix concrete. Equipment's for ready mix concrete plant. Conveying of ready-mix concrete. 2.2 Vibrators for concrete consolidation: Internal, needle, surface, platform and form vibrators. 2.3 Underwater Concreting: Procedure and equipment's required for Tremie method, Drop bucket method. Properties, workability and water cement ratio of the concrete. 2.4 Special concrete: procedure and uses of special concretes: Roller compacted concrete, Self-compacting concrete (SCC), Steel fibre reinforced concrete.	12
Unit – 3	**Advanced Technology in Constructions** 3.1 Construction of bridges and flyovers: Equipment's and machineries required for foundation and super structure. 3.2 Construction of multi-storeyed Building: Equipment's and machinery required for construction of multi-storeyed building such as use of lifts, belt conveyers, pumping of concrete. 3.3 Prefabricated construction: Methods of prefabrication, Plant fabrication and site fabrication, All prefabricated building elements such as wall panels, slab panels, beams, columns, door and window frames. Equipment's and machineries used for placing and Jointing of prefabricated elements.	10
Unit – 4	**Hoisting and Conveying Equipment's** 4.1 Hoisting Equipment's: Principles and working of Derrick-Pole, Gin Pole, Crane, Power driven scotch derrick crane, Hand operated crane, Locomotive crane, Tower crane, Truck mounted cranes. 4.2 Conveying Equipment's: Working of belt conveyers, types of belts and conveying mechanism.	10
Unit - 5	**Miscellaneous Machineries and Equipment's** 5.1 Excavation Equipment's: Use, working and output of following machinery – bull dozers, scrapers, graders, trenching equipment, Wheel mounted belt loaders, power shovels, JCB and drag lines. 5.2 Compacting Equipment's: Output of different types of rollers such as plain rollers ship footed rollers, vibratory, pneumatic rollers rammers. 5.3 Miscellaneous Equipment's: Working and selection of equipment: Pile driving equipment's, Pile hammers grouting equipment, guniting equipment's, floor polishing and cutting machine.	08
	Total	48

Text/ Reference Books:-		
Titles of the Book	Name of Authors	Name of the Publisher
Construction Engineering and Management	S C Sharma & S V Deodar	Khanna Book Publishing Co. New Delhi
Advanced Construction Technology	S.R. Kapoor	FPH (Foundation Publishing House)
Construction of Structures and Management of works	,S. C. Rangawala	Charotar Publication Anand
Construction Planning Equipment and Methods,	R.L. Peurifoy,	McGraw Hill Co. Ltd. New York

Course outcomes

After completing this course, student will be able to:

CO 1 : Use relevant materials in advanced construction of structures.

CO 2 : Use relevant method of concreting and equipment according to type of construction.

CO 3 : Apply advanced construction methods for given site condition.

CO 4 : Select suitable hoisting and conveying equipment for a given situation.

CO 5 : Identify advanced equipment required for a particular site condition

A)	Course Code	: 2000505B / 2000508B /2000511B
B)	Course Title	: Artificial Intelligence (Basics)
C)	Pre- requisite Course(s)	:
D)	Rationale	:

Artificial intelligence is the theory and development of computer systems able to perform tasks such as, visual perception, speech recognition, decision-making etc. normally requiring human intelligence. Data analytics gives the basis of developing any artificial intelligence system.

The Python programming language is one of the most accessible programming languages, has several modules to write programs to solve Artificial Intelligence, Machine Learning, Data Analysis problems. Moreover, it has simplified syntax and versatile data structures and functions to speed up the code writing efficiently.

This course provides the basics for Artificial Intelligence problem solving techniques, data analytics and articulates the different dimensions of these areas. This course also provides the students the foundations for data analytics with python. The course explains data science techniques and the various Python programming packages required to prepare data for analysis, perform data analytics and create meaningful data visualization.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course , the students will be able to-

CO-1 Elaborate the use of Artificial Intelligence for the problem solving as Technological driver.

CO-2 Write Python Programmes for solving problems.

CO-3 Analyze given data by using NumPy package of Python.

CO-4 Analyze given data by using Pandas package of Python.

CO-5 Visualize given data set using Matplotlib.

F) **Suggested Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)(if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1	-	2	2	-	-	-	1			
CO-2	-	3	3	3	-	-	2			
CO-3	-	3	3	3	-	-	2			
CO-4	-	2	3	3	-	-	2			
CO-5	-	3	3	3	-	-	2			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Scheme of Studies:

CourseCode	CourseTitle	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2000505B / 2000508B /2000511B	Artificial Intelligence (Basics)	02	-	04	02	08	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI : Laboratory Instruction(Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

SW: Sessional Work / Term Work(includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCS, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: SW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PLA)	End Laboratory Assessment (ELA)	
2000505B / 2000508B /2000511B	Artificial Intelligence (Basics)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

SWA: Sessional Work/ Term work& Self Learning Assessment (Includes assessment related to student performance in self learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

Theory: 100 marks

Practical 50 marks

I)   Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others must be integrated appropriately.

J)   Theory Session Outcomes (TSOs) and Units: [2000505B]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)

TSO 1a. Elaborate the use of Artificial Intelligence
TSO 1b. Explain various technological Drivers of Modern AI
TSO 1c. Describe Knowledge representation
TSO 1d. Classify Intelligent agents
TSO 1e. List the characteristics of agents
TSO 1f. Apply various search strategies for problem solving
	Unit-1.0. Artificial Intelligence
	    Artificial Intelligence: What is AI?, Types of AI, History of AI, Turing Test, Symbol Systems and the scope of Symbolic AI, Structure of AI, Goals of AI, Importance ofAI, Techniques used in AI, Perception, Understanding and Action**,** Technological drivers of modern AI
	    Knowledge: Definition, Knowledge Representation, objectives and requirements, practical aspects of representation, Components **Intelligent Agents**: Agents and Environments, Properties of environments, characteristics of agents, classification of agents
	    Problem Solving: Problem Formulation, Goal Formulation, State Space Search,Search Problem, Basic search algorithm,Search Tree, Search strategies – Uninformed and informed search, Breadth First Search, Depth First Search, Best First Search, Constraint Satisfaction Problem (CSP), Back tracking Search.Problem Definitions: N Queen Problem, 8Puzzle Problem, Tic-tac-Toe.
		CO-1

TSO 2a. Explain Python tokens and variables TSO 2b. Use the concept of l-value and r-value TSO 2c. Write python program using various data types TSO 2d. Write Program using various operators in Python TSO 2e. Write program using conditional	**Unit-2.0 Python Programming** 2.1 Python character set, Python tokens, variables, concept of l-value and r-value, use of comments. Data types: number (integer, floating point, complex), boolean, sequence (string, list, tuple), none, mapping (dictionary),	CO-2

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
statements. TSO 2f. Use various string functions for problem solving in python program TSO 2g. write programmes using various operations on list TSO 2h. Write programmes by using various operations on Tuples and Dictionary TSO 2i. Create user defined functions TSO 2j. Write python programmes using built-in functions TSO 2k. Describe the procedure to import module in the Python TSO 2l. Describe procedure to Import Library and functions in the Python TSO 2m. Write program using Iterative statements.	mutable and immutable data types Operators: arithmetic operators, relational operators, logical operators, assignment operator, augmented assignment operators. Expressions, statement, type conversion & input/output: precedence of operators, expression, evaluation of expression. **Conditional and Iterative statements:** if, if-else, if-elif-else, for loop, range function, while loop, break and continue statements, nested loops **String, List, Tuples and Dictionary:** String: indexing, string operations (concatenation, repetition, membership & slicing), traversing a string using loops, built-in functions. Lists: introduction, indexing, list operations (concatenation, repetition, membership & slicing), traversing a list using loops, built-in functions, linear search on list of numbers and counting the frequency of elements in a list Dictionary: accessing items in a dictionary using keys, mutability of dictionary (adding a new item, modifying an existing item), traversing a dictionary, built-in functions **Python Functions:** types of function (built-in functions, functions defined in module, user defined functions), creating user defined function, arguments and parameters, default parameters, positional parameters, function returning value(s), flow of execution, scope of a variable (global scope, local scope) **Modules and Packages:** Importing module using 'import' Regular Expressions, Exception Handling, PyPI Python Package Index, Pip Python package manager, Importing Libraries and Functions	

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3a. Explain Data Analytics and its elements TSO 3b. Differentiate Data Analysis and Data Analytics TSO 3c. Explain the use of open source data TSO 3d.Differentiate Qualitative and Quantitative data analysis TSO 3e. Explain procedure to Install NumPy Library TSO 3f. Use NumPy library to perform various operations and functions on array TSO 3g. Write Programs using NumPy for array manipulations	**Unit-3.0 Data Analytics and Computing with NumPy** Data Analytics: Data, Types of Data, Importance of Data, Data Analysis Vs Data Analytics, Types of Data Analytics, Elements of Analytics, Data Analysis Process, Qualitative and Quantitative analyses, Open Source Data. NumPy Library: Introduction, Installation, Ndarray: creating an array, intrinsic creation of an array, Data types, basic operations, aggregate functions, Indexing, slicing, Iterating, Conditions and Booleanarrays, Array manipulation: Joining, splitting, shape changing, sorting, Structured arrays, Reading and Writingarray data on a File.	CO-3
TSO 4a. Apply Pandas data structure for data analysis **TSO** 4b. Write Programs using Pandas to perform various operations and functions on series. **TSO** 4c. Perform various operation in a Data Frame columns and rows **TSO** 4d. Write Programme to read and write on CSV, XLS and Text data files **TSO** 4e. Apply various data cleaning operations and prepare data.	**Unit-4.0 Data Analysis with Pandas** Pandas data structures: Series, Declaration, selecting elements, assigning values, Filtering values, operations, mathematical functions, evaluating values, handling missing data, creating series from dictionaries, adding two series. Data Frame: Defining, selecting elements, assigning values, membership, deleting a column, filtering. Index Objects: Indexing, Re-indexing, Dropping, sorting and ranking, Descriptive Statistics Data Loading: Reading and Writing csv, xls, text data files, Data Cleaning and Preparation: Handling missing data, removing duplicates, replacing values,Vectorized String Methods, HierarchicalIndexing, Merging and Combining, Data aggregation and Grouping.	CO-4
TSO 5a. Illustrate the use of Matplotlib and PyPlot package for showing plots and images TSO 5b. Customize plots with Colors, Markers, Line Styles, Limits, Tics, Labels, Legends, Grids TSO 5c. Differentiate various charts based on their applications	**Unit-5.0 Data Visualization with Matplotlib** Data Visualization: Introduction to Matplotlib ,PyPlot package, Figures and Subplots, showing plots and images Customizing Plots: Colors, Markers, Line Styles, Limits, Tics, Labels, Legends, Grids , Annotating with text, Matplotlib configuration	CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	Chart types: Line, Bar, stacked bar, Box plots, pie chart , Histogram and Density plots, Scatter plot, Saving Plots to a file, Close and clear plots.	

Note: One major TSO may require more than one Theory session/Period.

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508B]

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
Use various data types and operators to solve given problem Use conditional and iterative statements for solving given problem	1	**Conditional and Iterative statements** 1a. Write a program to generate random numbers between 5 and 10. 1b. Write a program to find the square root of a number. 1c. Write a python program to check if a number is positive, negative or 0. 1d. Write Python program to print all prime numbers between 0-50.	CO-2
2.1Use string functions for performing various string operations	2	**String Handling** 2a. Write a Programme that asks the user for a string with only single space between words, and return number of words in the string. 2b. Write a Program that inputs a line of text and print the count of Vowels in it. 2c. Write a Program that inputs a line of text and print the biggest word in it. 2d. Write a Program that inputs a line of text and print a new line of text where each word of input line is reversed.	CO-2
Use list operations for concatenation, repetition & slicing Perform various operation in the Tuples Perform various operation in the dictionary	3	**List, Tuples and Dictionary** 3a. Write a python program to convert a string to a list. 3b. Write a program to print the largest number in a list. 3c. Given a tuple pairs = ((3,9), (8,4), (3,7), (24,18)), count the number of pairs (a, b) such that both a and b are odd. 3d. Write a program to input a list of numbers and swap elements at the even location with the elements at the odd location. 3e. Write a program to merge two dictionaries.	CO-2
4.1 Use built-in functions to solve given problem	4	**Python Functions** 4a. Write a function to reverse a string. 4b.Write a function to calculate the factorial of a	CO-2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
4.2 Create user defined functions tosolve given problem		number.	
use basic data structure using NumPy Convert the list and tuple as NumPy array	5.	**Basic data structures in NumPy** 5a. Create a List, set, tuple and dictionary which stores the details of a student (roll no, name, dept, branch, percentage of mark) in Python and print the values. 5b. Convert the list and tuple as NumPy array.	CO-3
Create Arrays in Numpy using different intrinsic methods Performarithmetic operations and mathematical operations using arange and ones intrinsicmethod.	6	**Arrays in NumPy** 6a. Create arrays using different intrinsic methods (ones, zeros, arange, linspace, indice) and print their values. 6b. Check the results of arithmetic operations like add(), subtract(), multiply() and divide() with arrays created using arange and ones intrinsic method. 6c. Check the results of mathematical operations like exp(), sqrt(), sin(), cos(), log(), dot() on an array created using arange intrinsic method.	CO-3
7.1 Apply aggregate functions on data by using Built-in functions in Numpy	7	**Built-in functions in NumPy.** 7a. Load your class Mark list data from a csv (comma separated value) file into an array. Perform the following operations to inspect your array. Len(), ndim, size, dtype, shape, info() 7b. Apply the aggregate functions on this data and print the results. (Functions like min(), max(), cumsum(), mean(), median(), corrcoef(), std())	CO-3
8.1 Handle multiple arrays by applying various operations on arrays	8	**Handling Multiple Arrays** 8a. Create two python NumPy arrays (boys, girls) each with the age of nstudents in the class. 8b. Get the common items between two python NumPy arrays. 8c. Get the positions where elements of two arrays match. 8d. Remove from one array those items that exist in another. 8e. Extract all numbers between a given range from a NumPy array.	CO-3
9.1 Apply indexing on the given set of data	9	**Indexing in NumPy** 9a. Load your class Mark list data from a csv file into an array. 9b. Access the mark of a student in a particular subject using indexing techniques. 9c. Select a subset of 2D array using fancy indexing (indexing using integer arrays	CO-3

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
Create series using list and dictionary in pandas Print different values from series.	10	**Working with a Series using Pandas** 10a. Create a series using list and dictionary. 10b. Create a series using NumPy functions in Pandas. 10c. Print the index and values of series. 10d. Print the first and last few rows from theseries.	CO-4
11.1 Perform various operation in aData Frame rows	11	**Working with Data Frame Rows** 11a. Slicing Data Frame using loc and iloc.11b. Filter multiple rows using isin. 11c. Select first n rows and last n rows 11d. Select rows randomly n rows and fractionsof rows (use df. sample method) 11e. Count the number of rows with each unique value of variables 11f. Select nlargest and nsmallest values.11g. Order/sort the rows	CO-4
12.1 Apply different techniques tomerge and combine data	12	**Merge and combine data** 12a. Perform the append, concat and combinefirst operations on Data Frames. 12b. Apply different types of merge on data. 12c. Use a query method to filter Data Frame with multiple conditions.	CO-4
Create Linear Plot to identify various relation in the data using Matplotlib Create Scatter Plot to identify various relation in the data using Matplotlib	13	**Consider the Salary dataset, which contains 30observations consisting of years of workingexperience and the annual wage. Download thedata set from** https://www.kaggle.com/rohankayan/years-of- experience-and-salary-dataset 13a. Create a linear plot to identify the relationship between years of workingexperience and the annual wages withsuitable title, legend and labels. 13b. Create a scatter plot to identify the relationship between years of working experience and the annual wages with title , legend and labels. 13c. Also distinguish between observations that have more than 5 years of working experience and observations that have	CO-5

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		of the Set osa iris class using a bar chart. 14b. Format the obtained bar graph by Changing the color of each bar, Change the Edge color, Line width and Line style.	

L)   Sessional Work and Self Learning: [2000511B]

a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. **Micro Projects:**

1. **Handing Two-dimensional array in NumPy**
    Download the data set from
    https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.datahttps://www.kaggle.com/arshid/iris-flower-dataset

    a. Import iris dataset with numbers and texts keeping the text intact into python NumPy.
    b. Convert the 1D iris to 2D array (iris2d) by omitting the species text field.
    c. Find the number and position of missing values in iris2d's sepal_length
    d. Insert np.nan values at 20 random positions in iris 2d dataset
    e. Filter the rows of iris2d that has petal_length> 1.5 and sepal_length< 5.0

    Expected Outcome(Use various operations on two dimensional arrays in NumPy)

2. **Handling missing data and duplicates in Pandas**
    a. Identify rows with missing data (isnull(), notnull()) and replace NA/Null data with a given value.
    b. Drop rows and columns with any missing data (dropna(), dropna(1))
    c. Find duplicate values and drop duplicates.
    d. Fill the missing values using forward filling and backward filling.
    e. Replace the missing value with new value and write the dataframe to a CSV file in the local directory.

    Expected Outcomes (a. Identify missing data, b. Find Duplicates values, c. Write the dataframe to a CSV file in the local directory.)

3. **Working with Data Frame Columns**
    a. Create and print a Data Frame.
    b. Find the descriptive statistics for each column.
    c. Group the data by the values in a specified column, values in the index.
    d. Set Index and columns in a Data Frame.
    e. Rename columns and drop columns
    f. Select or filter rows based on values in columns.
    g. Select single and multiple columns with specific names

Expected Outcome (Perform various operation in a Data Frame columns)

4. **Indexing & Sorting in NumPy**
    a. Load your class Mark list data from a csv file into an array.
    b. Sort the student details based on Total mark.

c. Print student details whose total marks is greater than 250 using Boolean indexing.

Expected Outcomes (a. Sort the given set of data, b. Use indexing in an array)

5. **Array Slicing in NumPy**
   a. Load your class Mark list data into an array called "marks" to store students roll num, subject marks and result.
   b. Split all rows and all columns except the last column into an array called "features".
   c. Split the marks array into 3 equal-sized sub-arrays each for 3 different subject marks.
   d. Split the last column into an array "label".
   e. Delete the roll num column from the marks array and insert a new column student name in its place.
   Expected Outcome (Use array slicing in NumPy for the given set of data)

6. Consider the Iris dataset, where observations belong to either one of three iris flower classes.
   Download the data set from
   https://www.kaggle.com/arshid/iris-flower-dataset

   a. Visualize the Histogram for each feature (Sepal Length, Sepal Width, petal Length & petal Width) separately with suitable bin size and color.
   b. Plot the histograms for all features using subplots to visualize all histograms in one single plot. Save the plot as JPEG file.
   c. Plot the box plots for all features next to each other in one single plot. Perform 3D printing of plastic casing of inhaler used by Asthma patients and estimate the cost.

   Expected Outcomes (a. Plot the Histogram for the various features using subplot, b. Plot the box plots for all features next to each other in one single plot)

c. **Other Activities:**

1. **Lab Activities**
   - Install Python IDE and important Python Libraries
   - Install Anaconda and find the features of Jupyter Notebook.
   - Import various module using 'import '
   - Use Pip Python package manager.
   - Import Libraries and Functions in Python

2. **Seminar Topics:**
   - Technological rivers of modern Artificial Intelligence
   - Intelligent Agents and Environments in Artificial Intelligence
   - Various Search Strategies
   - Python for Data Science
   - Python Libraries and Packages used in data Science
   - Data Visualisation
   - Various data set available over Internet

3. **Self-learning topics:**
   - Use of AI in Engineering and Technology
   - Data Science and Machine Learning
   - Problem and Goal Formulation
   - Search strategies
   - Breadth First Search and Depth First Search
   - Back tracking Search

- N Queen and 8 Puzzle Problem

M) **Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	20%	20%	--	30%	--	--
CO-2	10%	10%	20%	--	20%	20%	20%
CO-3	20%	20%	20%	30%	20%	20%	20%
CO-4	30%	30%	20%	20%	30%	30%	30%
CO-5	20%	20%	20%	50%	--	30%	30%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
* : Other Activities include self learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
 # : Mentioned under point-(O)
Note: For indirect assessment of COs, Course exit survey can be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Artificial Intelligence	CO-1	15	7	5	3
Unit-2.0. Python Programming	CO-2	15	4	3	8
Unit-3.0. Data Analytics and Computing with NumPy	CO-3	14	3	3	8
Unit-4.0. Data Analysis with Pandas	CO-4	13	3	3	7
Unit-5.0. Data Visualization with Matplotlib	CO-5	13	3	3	7
Total Marks		70	20	17	33

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O)   Specification Table for Laboratory (Practical) Assessment:

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Conditional and Iterative statements	CO-2	-	80	20
2.	String handling	CO-2	-	80	20
3.	List, Tuples and Dictionary	CO-2	20	70	10
4.	Python Functions	CO-2	-	80	20
5.	Basic data structures in NumPy	CO-3	-	80	20
6.	Arrays in NumPy	CO-3	-	80	20
7.	Built-in functions in NumPy.	CO-3	20	70	10
8.	Handling Multiple Arrays	CO-3	20	70	10
9.	Indexing in NumPy	CO-3	-	70	30
10.	Working with a Series using Pandas	CO-4	-	80	20
11.	Working with DataFrame Rows	CO-4	20	60	20
12.	Merge and combine data	CO-4	40	50	10
13.	Consider the Salary dataset, which contains 30 observations consisting of years of working experience and the annual wage.	CO-5	80	10	10
14.	Consider the Iris dataset, where observations belong to either one of three iris flower classes.	CO-5	80	10	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P)   Instructional/Implementation Strategies: Different Instructional/ ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Group Discussion, Portfolio Based Learning, Live Demonstrations in Classrooms, Lab, Information and Communications Technology(ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q)   List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Computer Systems	Desktop Computers with i3 processor, 16 GB RAM, 512 GB HDD	S.No. 1 to 14
2.	Online Python IDE	https://www.online-python.com/	S.No. 1 to 14
3.	Jupyter Notebook	Download from https://jupyter.org/	S.No. 1 to 14
4.	Pip Python package manager	Download Pip 22.3 From https://pypi.org/project/pip/	S.No. 1 to 14
5.	Various modules, Libraries and Packages	NumPy, Pandas, Matplotlib,PyPlot package	S.No. 1 to 14

R)   Suggested Learning Resources:

(a)   Suggested Books :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Artificial Intelligence Basics - A Non-Technical Introduction	TomTaulli	Apress(2019)
2.	Fundamentals of artificial Intelligence	Chowdhary K. R	Springer 2020
3.	Artificial Intelligence A Modern approach	Stuart J. Russell and Peter Norvig	PrenticeHall 2010, 3rdEdition
4.	Introduction to Computing and Problem Solving using Python	E. Balagurusamy	McGraw Hill Education(India)Pvt. Ltd. 1st Edition /2016
5.	Learning Python Programming	Jeffrey Elkner, Allan B.Downey, Chris Meyers	Samurai Media Limited. 2016
6.	Python Programming	Ashok Namdev Kamthane and Amit Ashok Kamthane	McGraw Hill Education(India) Pvt.Ltd.2020, 2nd Edition
7.	Programming in Python	Dr. Pooja Sharma	BPB Publications 2017
8.	Taming Python By Programming	Jeeva ose	Khanna Book Publishing Co(P)Ltd , 2017, Reprinted2019
9.	Python Data Analytics	Fabio Nelli	Apress,2015
10.	Python for Data Analysis: Data Wrangling with Pandas, Numpy, and IPython	Wes McKinney	O'REILLY 2018,SecondEdition

(b)   Suggested Open Educational Resources (OER):

1. NPTEL Web Content- Artificial Intelligence, Prof. P. Mitra, Prof. S. Sarkar, IIT Kharagpur URL: https://nptel.ac.in/courses/106/105/106105078/
2. https://www.learnpython.org
3. www.python.org
4. https://www.tutorialspoint.com/python

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c)   Others: (If any)

Data Source:
- https://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/
- https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data
- https://www.kaggle.com/arshid/iris-flower-dataset
- https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset

S)   Course Curriculum Development Team(NITTTR)
- Dr. Sanjay Agrawal(Coordinator)
- Dr. R. K. Kapoor(Co-coordinator)

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A) **Course Code** : **2000505C / 2000508C / 2000511C**
B) **Course Title** : **Internet of Things (Basic)**
C) **Pre- requisite Course(s)** : **Digital Electronics, Electronics Circuits, Fundaments of Computers and Computer networks**

D) **Rationale:**

The Internet of Things (IoT) is the upcoming field that has the capability to connect everything on the earth. This course focuses on the development of IoT concepts such as sensing, actuation with implementation of communication protocols.

The course also focuses on real life aspects of IoT and how to integrate it in real life projects. The course will simplify the concept of IoT by using the Node MCU board for IoT application development. In this course students will learn about the use of Node MCU and its applications as a beginner/intermediate in the field of IoT. Apart from this, students will learn about the APIs, by using which integration of features like send Email, WhatsApp messages and notification based on certain events in projects is possible. Overall, this course covers both hardware and software aspects of IoT with practical exposure.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Describe the functions of each block of the basic IoT system

CO-2 Explain communication protocol used in IoT and its applications

CO-3 Use appropriate sensors for the specific measurement through the IoT platform

CO-4 Explain APIs, client-server connections and its integration in real life applications.

CO-5 Build and test a complete, working IoT system involving prototyping, programming, and data analysis

F) **Suggested Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1	3	-	-	-	-	-	-			
CO-2	1	2	2	2	2	-	-			
CO-3	1	3	2	2	2	2	2			
CO-4	1	1	2	3	-	2	2			
CO-5	1	1	3	2	2	3	3			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Scheme of Studies:

CourseCode	CourseTitle	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C) (CI+LI+SW+SL)
		L	T				
2000505 C / 2000508 C / 2000511C	**Internet of Things (Basic)**	02	-	04	02	08	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI : Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

SW: Sessional Work/Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCS, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: SW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA +LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment(ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PLA)	End Laboratory Assessment (ELA)	
2000505 C / 2000508 C / 2000511C	Internet of Things (Basic)	30	70	**20**	**30**	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

SWA: Sessional Work/Term work& Self Learning Assessment (Includes assessment related to student performance in self learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

Theory: 100 marks
Practical 50 marks

I) Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others must be integrated appropriately.

J)   Theory Session Outcomes (TSOs) and Units: [2000505C]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1.a. Describe the concept of IoT. TSO.1.b. Explain the functions of each block of the Basic IoT system. TSO.1.c. Compare features of various IoT platforms TSO.1.d. List IoT Real time Applications. TSO.1.e. Describe the functioning of given real-time applications	**Unit-1.0 Introduction to IoT** Basics of IoT, concepts of IoT, History of IoT Basic IoT System and its building blocks Various platforms for IoT (e.g. AWS, AZURE, GCP) Introduction to Python programming andIoT software Applications of IoT	CO-1 and CO-5
TSO.2.a.Explain various communication protocols. TSO.2.b.Explain working and application of blue tooth TSO.2.c.Explain working and application of ZigBee TSO.2.d.Explain working and application of LoRa TSO.2.e.Explain working and application of Wi-fi	**Unit 2. IoT Communication protocols** Basics of given communication protocol along with its applications Explain Communication Protocols MQTT Bluetooth Low Energy ZigBee LoRa Wi-fi	CO-1 and C02
TSO.3.a. Differentiate between sensor and Actuator. TSO.3.b. Classify IoT sensors on the basis of their application. TSO.3.c. Describe the function of each block of Node MCU. TSO.3.d. Explain the procedure to connect sensors with Node MCU.	**Unit-3.0 Sensors and Hardware for IoT** Sensors and Actuators, Transducers, Classifications of sensors, IoT Sensors Development Boards, classifications, and basics of wireless networks, WiFi libraries Introduction to node MCU, block diagram, functions, interfacing with sensors and publishing data on webserver Device integration with node MCU Interfacing of sensors with boards	**CO-1, CO-3 and CO-5**
TSO.4.a. Define APIs and its uses TSO.4.b.Explain working and application of REST. TSO.4.c.Explain working and application of SOAP TSO.4.d.Explain working and application of json TSO.4.e.Explain the integration of API in IoT application development.	**Unit.4 IoT APIsand its Integration** Explain APIs and its use Explanation of given IoT APIs along with its applications MQTT, Broker, subscriber, publisher **REST** **SOAP** **4.5 JSON** **4.6 Programming API using Python**	**CO-1 and CO-4**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.5.a. Differentiate between industrial IoT and IoT. TSO.5.b. Describe the applications of IoT in the medical field. TSO.5.c. Describe the medical applications of IoT in the agriculture field. TSO.5.d. Describe the innovative IoT applications.	**Unit. 5 IoT Applications**: - Industrial IoT and Internet of everything IoT for consumer electronics products IoT for Medical applications IoT for Agriculture IoT for security and Law enforcement	**CO-1 and CO-5**

Note: One major TSO may require more than one Theory session/Period.

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508 C]

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 List various IoT platforms. List Down broad features of given platforms. List IoT based features in python language.	1.	Prepare a list of platforms used for IoT. Prepare a list of features of above IoT platforms. Prepare a list of features provided by python language for IoT applications.	**CO-1**
LSOs 2.1 Arduino connection with Arduino IDE. Connect Bluetooth with Arduino. verification of data communication with Bluetooth.	2.	Establish connectivity between various components of IoT. Establish connection between Arduinoand Bluetooth module. Establish connection using WiFi	**CO-2**
LSO 3.1 Measure the temperature of the given sensor. LSO 3.2 Measure the humidity of the given sensor. LSO 3.3 Measure the pressure of the given sensor.	3.	Publish data on the IoT platform. Measure the temperature of a remotely located temperature sensor Using IOT based temperature data-monitoring system. Measure the humidity of a remotely located humidity sensor Using IOT based humidity data-monitoring system. Measure the pressure of a remotely located pressure sensor Using IOT based pressure data-monitoring system.	**CO-3**
LSO 4.1 Working with APIs. LSO 4.2 Implementation of APIs using POSTMAN Application.	4	Download and Configure POSTMAN Application Verify REST APIs through POSTMAN. Verify JSON APIs through POSTMAN. Verify SOAP APIs through POSTMAN.	**CO-4**
LSO 5.1 Identification of components for various applications. LSO 5.2 Estimate the cost for components.	5.	Identify components for given project Estimate the cost to make Project working.	**CO-5**

L)   Sessional Work and Self Learning: [2000511C]

a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b.   **Micro Projects:**
1. Prepare a report on IoT Systems using Internet data.
2. Market survey to identify various types of IoT sensors and its pricing.
3. Interface IR sensor with Arduino and send the data to Arduino cloud.
4. Send IoT data using Node MCU to things Speak cloud.
5. Interface Bluetooth module with Arduino and send data using the Bluetooth module.

c.   **Other Activities:**
1. Seminar Topics: - "Future of IoT"
       "Technologies for IoT ", "Smart City and IoT"
2. Visit to industry for latest IoT setup in industrial process.
3. Surveys of market for availability of various types of sensors and its pricing.
4. Product Development: Development of projects for real life problem solution using IoT.
5. Software Development: various open source platform operations.

6. **Self-learning topics:**
1. IoT hardware and their use for various applications
2. IoT sensors technical specifications
3. IoT enabled services

M)   Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	20%	--	33%	10%	20%
CO-2	15%	10%	20%	--	33%	15%	20%
CO-3	30%	30%	20%	--	34%	15%	20%
CO-4	20%	30%	20%	50%	--	30%	20%
CO-5	25%	20%	20%	50%	--	30%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*   **:**   Other Activities include self learning, seminar, visits, surveys, product development, software development etc.
****:   Mentioned under point- (N)
 # :   Mentioned under point-(O)
Note: For indirect assessment of COs, Course exit survey can be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Introduction to IoT	CO-1	5	3	2	-
Unit-2.0. IoT Communicationprotocols	CO-2	9	4	3	2
Unit-3.0. Sensors and Hardware for IoT	CO-3	19	5	6	8
Unit-4.0 IoT APIs and its Integration	CO-4	19	5	5	9
Unit-5.0. IoT Applications	CO-5	18	3	6	9
	Total Marks	**70**	**20**	**22**	**28**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Specification Table for Laboratory (Practical) Assessment:**

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Prepare a list of platforms used for IoT.	CO-1	60	30	10
2.	Prepare a list of features of above IoT platforms.	CO-1	60	30	10
3.	Prepare a list of features provided by python language for IoT applications.	CO-1	60	30	10
4.	Establish connectivity between various components of IoT.	CO-2	60	30	10
5.	Establish connection between Arduino and Bluetooth module.	CO-2	60	30	10
6.	Establish connection using WiFi	CO-2	70	20	10
7.	Publish data on the IoT platform.	CO-3	70	20	10
8.	Measure the temperature of a remotely located temperature sensor Using IOT based temperature data-monitoring system.	CO-3	60	40	10
9.	Measure the humidity of a remotely located temperature sensor Using IOT based temperature data-monitoring system.	CO-3	60	40	10
10.	Measure the pressure of a remotely located temperature sensor Using IOT based temperature data-monitoring system.	CO-3	60	40	10
11.	Publish the data using Mqtt	CO-4	60	30	10
12.	Download and Configure POSTMAN Applications	CO-4	60	30	10
13.	Verify REST APIs through POSTMAN.	CO-4	60	30	10
14.	Verify JSON APIs through POSTMAN.	CO-4	60	30	10
15.	Verify SOAP APIs through POSTMAN.	CO-4	60	30	10
16.	Identify components for given project	CO-5	50	40	10
17.	Estimate the cost to make Project working.	CO-5	50	40	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriatelyselected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1	Bluetooth Modem-BlueSMiRF Silver	Sparkfun Bluetooth modem	As mentioned above list
2	Postman Software	Open-source downloadable	
3	Node MCU board	Generic	
4	IoT free cloud	Arduino cloud/Thing Speak/Blynk	
5	ATAL Lab Package-1 Package-2 Package-4	As per the list as address below ATAL Equipment list' (http://aim.gov.in/guidelines-for-school.php).	

R) **Suggested Learning Resources:**

(a) **Suggested Books** :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Internet of Things Architecture and Design Principles	Raj Kamal	Mc Graw Hills, New Delhi ISBN 13: 978-93-90722-38-4

2	Internet of things (IoT) : technologies, applications, challenges and solutions	Edited By BK Tripathy , J Anuradha	CRC Press ,ISBN 9780367572921, June 30, 2020	
3	Internet-of-Things (IoT) Systems: Architectures, Algorithms, Methodologies	by Dimitrios Serpanos & Marilyn Wolf	Springer; 1st ed. 2018 edition (17 January 2018)	
4	Custom Raspberry Pi Interfaces: Design and build hardware interfaces for the Raspberry	Pi by Warren Gay	Apress; 1st ed. edition (23 February 2017), ISBN-10 : 9781484224052, ISBN-13 : 978-1484224052	
5	'Learning Internet of Things',	Peter Waher	Packt Publishing, 2015, ISBN 9781783553532, https://lib.hpu.edu.vn/handle/123456789/31693	
6	Sensors, Actuators and Their Interfaces,	N. Ida	Scitech Publishers, 2014.	

(b) **Suggested Open Educational Resources (OER):**

1. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
2. en.wikipedia.org/wiki/Shear and moment diagram
3. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
4. www.engineerstudent.co.uk/stress_and_strain.html
5. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
6. https://www.veritis.com/blog/aws-vs-azure-vs-gcp-the-cloud-platform-of-your-choice/
7. https://wiki.python.org/moin/TimeComplexity
8. www.engineerstudent.co.uk/stress_and_strain.html
9. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
10. Amini, P. (2014). Sulley: Pure Python fully automated and unattended fuzzing frame- work.
11. https://github.com/OpenRCE/sulley

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c) **Others: (If any)**

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

S) **Course Curriculum Development Team(NITTTR)**

- Dr. M. A. Rizvi(Coordinator)
- Dr. Anjali Potnis(Co-coordinator)

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A)	Course Code	:	2000505D / 2000508D / 2000511D
B)	Course Title	:	Drone Technology (Basics)
C)	Pre- requisite Course(s)	:	
D)	Rationale	:	

Rapid technological innovation has provided users cutting-edge products at affordable prices. Traditionally, drones had been limited to military use due to high costs and technical sophistication. In recent years, the drone has number of commercial uses and are also proving to be extremely beneficial in places where a man cannot reach or is unable to perform in a timely and efficient manner. Today, drones are used in construction, photography, agriculture, defense, environmental studies and monitoring and other industries to protect the skies, repopulate forests and accomplish much more on a huge scale. This course will acquaint the student with the basic drone technology and applicable drone rules and regulations in India. Considering that the main operational areas of diploma holders, it is essential that he should be exposed to basic drone designing, programming, operating, maintaining and using them safely.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Operate a drone safely by applying appropriate drone rules and regulations.

CO-2 Design the structure of drone with drone components and equipment.

CO-3 Interface flight controller board with sensors, ESC and radio communication unit in drone technology.

CO-4 Use drone simulator and identify different types of ports and connectors of drone.

CO-5 Use python programming while drone designing.

F) **Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)(if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2Problem Analysis	PO-3Design/ Development of Solutions	PO-4Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1	2	-	-	-	3	-	2			
CO-2	3	2	3	3	-	-	-			
CO-3	3	2	3	3	-	-	-			
CO-4	2	-	-	2	-	3	2			
CO-5	-	2	2	3	-	-	-			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Scheme of Studies:

CourseCode	CourseTitle	Scheme of Studies (Hours/Week)				
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C) (CI+LI+SW+SL)
		L	T				
2000505D / 2000508D / 2000511D	Drone Technology (Basics)	02	-	04	02	08	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI : Laboratory Instruction(Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours:Hours of engagement by learners, other than the contact hours for ensuring learning.

SW: Sessional Work/Term work(includesassignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCS,spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: SW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment(ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PLA)	End Laboratory Assessment (ELA)	
200505D / 200508D / 200511D	3D Printing and Design (Basics)	30	70	**20**	**30**	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

SWA: Sessional Work/Term work& Self Learning Assessment (Includes assessment related to student performance in self-learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

I) Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others must be integrated appropriately.

J)   Theory Session Outcomes (TSOs) and Units: [2000505D]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Describe the various historical evolutionary steps of drone technology TSO 1b. Explain Drone motion based on principle of aerodynamics. TSO 1c. Classify different types of drones and make chart of its application, advantages and disadvantages. TSO 1d. Develop attitude to follow proper rules and regulations of drones flying in India. TSO 1e. Explore future prospects of drones in India.	**Unit-1.0Introduction to Drone Technology** Introduction to Drones and UAV • Definition • History • Drone in Indian aspect Introduction to Flight Dynamics Various types of Drones and their respective Applications • Multirotor drones • Fixed wing structure Drone flights using an understanding of FAA • DGCA • Digital sky platform • RPTO 1.5 Drone regulations-No drone zones	CO-1
TSO 2a. Explain the use and function of different types of Drone components. TSO 2b. Select suitable drone frame and propellers for given application. TSO 2c. Explain working principle and function of different sensors used indrone technology. TSO 2d. Write use of Gyro sensor and Accelerometer in drone. TSO 2e. Describe different types and capacity of Battery used in various drone applications. TSO 2f. State the selection criteria of motor for given drone application. TSO 2g. Write advantage of BLDC motors in making of Drones.	**Unit-2.0Droneand its components** Drones components • Drone frame • Propellers Sensors • Gyro sensor and Accelerometer • Speed and Distance Sensor • Temp sensor • Barometer • TOF Sensor Battery • Types and Capacity Motors • Motor types • Motor capabilities • Application of BLDC motors in drones	CO-2
TSO 3a. Explain four types of motion used in drone's operation. TSO 3b. Describe the working and applications of Electronic speed controller. TSO 3c. Explain the working principle of Flight controller unit used in drone.	**Unit-3.0 Drone controller and motion** Propulsion and Vertical Motion Controller and Flying Instructions • Electronic speed Controller (ESC) • Flight Controller Board(FCB)	**CO-3**

Major Theory Session Outcomes (TSOs)		Units	Relevant COs Number(s)
TSO 3d.	Explain Radio communication unit used in drone.	Radio Communication • Transmitter and Receiver for radio signal	
TSO 3e.	Explain the communication of Flight controller board with motor, ESC and sensors with suitable diagram		
TSO 4a.	Describe utility of different communication port used in drone.	**Unit-4.0 Connections and Interfaces of Devices in Drone and Drone Simulator** Communication Port • PWM • RS232, RS422, RS485 • UART • CAN • I2C Different types of connectors and its specification Drone Simulator software Drone simulator Hardware	**CO-4**
TSO 4b.	Identifydifferent types of connectors and write their specifications.		
TSO 4c.	Explain the use of drone simulator software and hardware.		
TSO 5a.	Write basic code in Python.	**Unit-5.0 Introduction to Python for Drone** Python programing refreshers for IoT, AI and Drone Integration of devices with cloud services Microsoft Azure, AWS	**CO-5**
TSO 5b.	Explain structure and components of a Python program.		
TSO 5c.	write syntax of loops and decision statements in Python.		
TSO 5d.	Explain steps to create functions and pass arguments in Python.		

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508D]

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1 Choose suitable materials for making drone frame.	1.	Determine the strength of materials used in drones frame.	CO-2
LSO 2 Select suitable materials for making drone propellers.	2.	Determine the strength of materials used in drones Propellers.	CO-2
LSO 3 Use appropriate battery as per need of flight time for specific drone application.	3.	Test different parameters of batteries used in drones	CO-2
LSO 4 Identify suitable motors as per payload of specific drone application.	4.	Test motors suitable for specific Drone application.	CO-2
LSO 5 Operate Gyro sensor and Accelerometer.	5.	Test and measure Gyro sensor and Accelerometer and their characteristics.	CO-2
LSO 6.1 Identify different sensors based on their characteristics. LSO 6.2 Interface different types of sensor in drone.	6.	Test different sensors and their characteristics with Microcontroller based Flight controller board.	CO-2, CO-3
LSO 7 Demonstrate four type of drone motion.	7.	Determine thrust/torque of motor by changing different drone motion	CO-2, CO-3
LSO 8.1 Configure Flight control board (FCB) LSO 8.2 Demonstrate use of Flight control board (FCB)	8.	Test and troubleshoot Flight control board (FCB).	CO-3
LSO 9.1 Measure various parameters of sensor LSO 9.2 Interface sensor with flight controller board.	9.	Test and perform communication of Flight control board (FCB) with sensor	CO-3, CO-2
LSO 10 Use motor with flight controller board.	10.	Test and perform communication of Flight control board (FCB) with motor.	CO-3, CO-2
LSO 11 Interface ESC with flight controller board.	11.	Test and perform communication of Flight control board with ESC.	CO-3
LSO 12 Configure radio communication device to control drones	12.	Test and perform communication of Flight control board with RF transceiver.	CO-3
LSO 13.1 Identify different types of ports and connectors of drone. LSO 13.2 Assemble drone component.	13.	Test Hardware assembly for drone.	CO-4 CO-3
LSO 14.1 Identify different motions in drone simulator. LSO 14.2 Operate drone in simulator for specific task	14.	Perform different motion in drone simulator.	CO-4
LSO 15.1 Write code of loop and decision statement in python. LSO 15.2 Interpret loop and decision statement LSO 15.3 Debug code of loop and decision statement	15.	Build and run loops and decision statements for specific application in Python.	CO-5
LSO 16.1 Make function in python. LSO 16.2 Interpret given function statement	16.	Build and Run functions for specific application and pass arguments in Python.	CO-5

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 16.3 Debug code of function in python			
LSO 17.1 Identify python programming steps to interface drone components.	17.	Write basic programming in python to interface different component of Drones.	CO-5, CO-3
LSO 17.2 Identify error in python program			
LSO 17.3 Debug the given python program			

L)   Sessional Work and Self Learning: [2000511D]

    a.   Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

    b.   Micro Projects:
1. Design drone for simple application.
2. Test different sensors, their characteristics and make chart which are used in different drones' applications.
3. Download 5 videos on drone design with different components. Watch them and write report on it.
4. Write report on Drone application for precision agriculture.
5. Survey nearby electronics shop and Prepare report of list of drone component and its specification.
6. Visit nearby tool room, small industry, Drone training institute facilities. Prepare report of visit with special comments of drone technology used, material used, cost of printed component.

    c.   Other Activities:
1. Seminar Topics-History of Drone, Drone regulations, Proximity sensor, Bernoulli's principle apply in drone, Radio communication used in drones, Drone Simulator, Python Programming.
2. Visits: Visit nearby tool room, small industry, Drone training institute facilities. Prepare report of visit with special comments of drone technology used, material used, cost of printed component.
3. Surveys: Survey nearby electronics shop and Prepare report of list of drone component and its specification and explore Drone simulator.
4. Product Development
5. Software Development

    d.   Self learning topics:
1. History of Drones
2. Drone in Indian aspect
3. Drone regulations
4. Principle of aerodynamics for Drones
5. Drone simulator

M)   Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. There sponse /performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

Course Evaluation Matrix					
Theory Assessment (TA)**		Sessional Work Assessment (SWA)	Lab Assessment (LA)#		
Progressive Theory Assessment	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	

COs	(PTA) Class/Mid Sem Test		Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	10%	--	10%	-	-
CO-2	30%	30%	30%	33%	30%	30%	30%
CO-3	30%	30%	30%	34%-	30%	30%	30%
CO-4	15%	10%	15%	-	15%	20%	20%
CO-5	15%	20%	15%	33%	15%	20%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
* : Other Activities include seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
 # : Mentioned under point-(O)
Note: To calculate CO attainment 80% weightage of direct assessment tools and 20% of indirect assessment tools may be taken.

N) Specification Table for End Semester Theory Assessment: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0. Introduction to Drone Technology	CO-1	08	03	02	03
Unit-2.0. Drone and its component	CO-2	20	05	07	08
Unit-3.0. Drone controller and motion	CO-3	20	05	07	08
Unit-4.0. Connections and Interfaces ofDevices in Drone and Drone Simulator	CO-4	08	03	02	03
Unit-5.0. Introduction to Python for Drone	CO-5	14	04	04	06
	Total Marks	70	20	22	28

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Specification Table for Laboratory (Practical) Assessment:

S.No	Laboratory Practical Titles	Relevant COs Number(s)	PLA #/ELA # (Marks)		
			Performance		Viva-Voce (…%)
			PRA (…%)	PDA (…%)	
1.	Determine the strength of materials used in drones frame.	CO-2	60	30	10
2.	Determine the strength of materials used in drones Propellers.	CO-2	60	30	10
3.	Test different parameters of batteries used in drones	CO-2	50	40	10
4.	Test motors suitable for specific Drone application.	CO-2	50	40	10
5.	Test and measure Gyro sensor and Accelerometer and their characteristics.	CO-2	50	40	10
6.	Test different sensors and their characteristics with Microcontroller based Flight controller board.	CO-2, CO-3	50	40	10
7.	Determine thrust/torque of motor by changing different drone motion	CO-2, CO-3	60	30	10

S.No	Laboratory Practical Titles	Relevant COs Number(s)	PLA #/ELA # (Marks)		
			Performance		Viva-Voce (...%)
			PRA (...%)	PDA (...%)	
8.	Test and troubleshoot Flight control board (FCB).	CO-3	60	30	10
9.	Test and perform communication of Flight control board (FCB) with sensor	CO-3, CO-2	60	30	10
10.	Test and perform communication of Flight control board (FCB) with motor.	CO-3, CO-2	60	30	10
11.	Test and perform communication of Flight control board with ESC.	CO-3	60	30	10
12.	Test and perform communication of Flight control board with RF transceiver.	CO-3	60	30	10
13.	Test Hardware assembly for drone.	CO-4 CO-3	50	40	10
14.	Perform different motion in drone simulator.	CO-4	50	40	10
15.	Build and run loops and decision statements for specific application in Python.	CO-5	50	40	10
16.	Build and Run functions for specific application and pass arguments in Python.	CO-5	50	40	10
17.	Write basic programming in python to interface different component of Drones.	CO-5, CO-3	50	40	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology(ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	Drone Frame	Tricopter/Quadcopter/Hexacopter	1-13
2.	Propellers	10X4.5 CW/Others	1-13
3.	Speed Sensor	3.3 or 5.0Vdc	1-13
4.	Distance Sensor	5Volt operating voltage	1-13
5.	Gyro sensor and Accelerometer	5Volt operating voltage	1-13
6.	Barometer	Altitude tracking, temp range from 25°C to 40°C	1-13

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
7.	TOF Sensor	Accurate ranging up to 4 m, Fast ranging frequency up to 50	1-13
8.	Battery	Lithium Polymer Battery,2200mAH/others	1-13
9.	Motor	BLDC,1000kv or 1000RPM/volt	1-13
10.	Electronic speed Controller (ESC)	30 Amp,2-4s or cell	1-13
11.	Flight Controller Unit	KK 2.1.5/ ArdupilotAPM 2.8/ Pixhawk/others	1-13
12.	Transmitter and Receiver for radio signal	4 channels/6 Channels, 2.4 GHz & 5.8 GHz	1-13
13.	Drone Simulator Software	RC flight simulator	14
14.	Python Software	Hardware required-More than 4 GB RAM, 64 bit CPU preferable	15,16,17

R) Suggested Learning Resources:

(a) Suggested Books :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Make: Getting Started with Drones: Build and Customize Your Own Quadcopter	Terry Kilby&Belinda Kilby	Shroff/Maker Media, First edition 2016, ISBN-978-9352133147
2.	Agricultural Drones: A Peaceful Pursuit	K R Krishna	Apple Academic Press,1st edition 2018, ISBN-978-1771885959
3.	DIY Drone and Quadcopter Projects: A Collection of Drone-Based Essays, Tutorials, and Projects	Editors Of Make	Shroff/Maker Media; First edition 2016, ISBN-978-9352133994
4.	Building Multicopter Video Drones: Build and fly multicopter drones to gather breathtaking video footage	Ty Audronis	Packt Publishing Limited; Illustrated edition,2014,ISBN-978-1782175438
5.	The Complete Guide to Drones	Adam Juniper	Ilex Press, Extended 2nd Edition,2018 ISBN-9781781575383

(b) Suggested Open Educational Resources (OER):

1. https://nptel.ac.in/courses/101104073
2. https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle
3. https://www.scienceabc.com/innovation/what-is-drone-technology.html
4. https://www.dronezon.com/learn-about-drones-quadcopters/what-is-drone-technology-or-how-does-drone-technology-work/
5. https://www.youtube.com/watch?v=OWaXIK9sHeE
6. https://books.google.co.in/books?id=2M0hEAAAQBAJ&printsec=copyright&redir_esc=y#v=onepage&q&f=false

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c)   Others: (If any)

1. Learning Packages

2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

S)   Course Curriculum Development Team(NITTTR)
- Dr. K. K. Jain (Coordinator)
- Dr. Sanjeet Kumar (Co-coordinator)

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A)	**Course Code**	: **2000505E / 2000508E / 2000511E**
B)	**Course Title**	: 3D Printing and Design (Basics)
C)	**Pre- requisite Course(s)**	: Computer aided Modeling
D)	**Rationale**	:

Additive manufacturing (AM) or Additive layer manufacturing (ALM) is the industrial production name for 3D Printing. 3D Printing is a process that makes solid objects from a digital model. It involves depositing material either metal, powdered plastic, or liquid in thin layers (2D) to get a 3D object. This basic course on 3D Printing tries to develop understanding of the process of making real object from digital model in the students. It also covers the software/hardware required, various materials used for 3D Printing and details about printing process parameters. The knowledge gained through this course will help the students to take up advanced course on 3D Printing in next semester.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Develop CAD models for 3D Printing.

CO-2 Import and Export CAD data in .STL file format to generate GCODE file.

CO-3 Select suitable 3D Printing material for given applications.

CO-4 Select suitable 3D Printing process for given situations.

CO-5 Produce products using most popular FDM/SLA/SLS 3D Printing processes.

F) **Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	-	3	2	-	-	2			
CO-2	3	2	-	2	-	-	-			
CO-3	3	3	-	2	3	-	-			
CO-4	3	3	-	2	-	-	-			
CO-5	3	-	3	3	-	3	2			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) **Scheme of Studies:**

CourseCode	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2000505E / 2000508E / 2000511E	3D Printing and Design (Basics)	02	-	04	02	08	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI : Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

SW: Sessional Work/Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: SW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2000505E / 2000508E / 2000511E	3D Printing and Design (Basics)	30	70	**20**	**30**	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

SWA: Sessional Work/Term work & Self Learning Assessment (Includes assessment related to student performance in self learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

I) Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units: [2000505E]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain CAD-CAM and related terminologies. *TSO 1b.* Convert the given CAD file format into others. *TSO 1c.* Transfer the given CAD data to CAM facilities. *TSO 1d.* Classify 3D Printing processes. *TSO 1e.* List the advantages of additive manufacturing processes over	**Unit-1.0 Additive Manufacturing Introduction and CAD** CAD-CAM and its integration CAD- Part and Surface modeling CAD file formats Additive v/s Conventional Manufacturing processes Process chain for 3D Printing Classification of 3D Printing Processes Product design and prototyping	CO1

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
conventional manufacturing processes. TSO 1f. List typical steps involved in 3D printing of an object from digital model. TSO 1g. Explain reverse engineering steps for 3D Printing.	1.8 Reverse Engineering for 3D Printing	
TSO 2a. Explain the given STL interface terminology. TSO 2b. Use the given alternative 3D printing interface. TSO 2c. Generate STL file for the given CAD file. TSO 2d. Repair the given STL file. TSO 2e. Apply part orientation and support techniques for the given situation. TSO 2f. Perform slicing of the given CAD model using the given slicing software. TSO 2g. Generate tool path using simulation software for the given situation.	**Unit-2.0 Data Preparation for 3D Printing** STL interface Specification, STL data generation, STL data Manipulation, Advantages and limitations of STL file format, Open files, Repair of STL files, Alternative 3D Printing interfaces Part orientation and support generation, Factors affecting part orientation, Various models for part orientation determination, The function of part supports, Support structure design, Automatic support structure generation Model Slicing and Contour Data organization, Direct and adaptive slicing:Identification of peak features, Adaptivelayer thickness determination Tool path generation	CO1, CO2
TSO 3a. Explain the given 3D Printing processe. TSO 3b. List process parameters of the given 3D Printing processes. TSO 3c. Select 3D Printing materials for the given application. TSO 3d. Select 3D Printing processes among FDM, SLS, SLA for given application with justification.	**Unit-3.0 Additive Manufacturing Techniques** Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology, Direct Energy Deposition Process parameter, Process Selection for various applications 3D Printing materials and selection Comparison between FDM, SLS, SLA	CO3, CO4
TSO 4a. Identify various Aerospace, Electronics, Health care, Automotive, Construction, Food processing, Machine tool components that can be 3D Printed. TSO 4b. Estimate the cost and time of 3D printing of the given component.	**Unit-4.0 Application of 3D Printing** 4.1 Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defense, Automotive, Construction, Food Processing, Machine Tools	CO3, CO4
TSO 5a. Select suitable 3D Printer and software for the given application with justification. TSO 5b. Analyze the effect of given 3D printing process parameters using 3D printer software simulation. TSO 5c. List steps to perform 3D scanning of the given object.	**Unit-5.0 3D Printers and Software and Scanners** Construction details and working of established 3D printers for plastics parts only: Stereolithography (SLA), Selective Laser Sintering (SLS), and Fused DepositionModeling (FDM). Accuracy, Precision and Tolerance in 3D printing. 3D Printer software- Fusion 360,	CO4, CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 5d. Repair 3D scanned digital model. *TSO 5e.* Set different 3D printing process parameters to get a sound plastic component.	Solidworks, Onshape, Tinkercad, Ultimaker Cura, MeshLab, Simplyfy 3D, Repetier host, Slic3r, etc. – use and operation of anyone. 3D Scanners and working. Producing a part using FDM, SLA and SLS 3D Printer	

Note: One major TSO may require more than one Theory session/Period.

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508E]

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use CAD software. *LSO 1.2.* Prepare digital models of simple 3D entities.	1.	Develop digital models of following simple components using any CAD software: • Nut • Bolt • Network cable Jack • Coat button • Spoon	CO1
LSO 2.1. Prepare digital models of complex 3D entities and assemblies.	2.	Develop digital models of following assemblies using any CAD software: • Connecting Rod • Piston • Electric switch • Bathroom Tap • Mouse	CO1
LSO 3.1. Surf web for downloading readymade free CAD models. *LSO 3.2.* Convert one CAD file format into another.	3.	Download three digital CAD models freely available on web in different formats and then convert them into .stl/obj format.	CO1
LSO 4.1. Use the given Slicing software for 3D Printing. *LSO 4.2.* Perform slicing operation on the given digital model.	4.	Perform slicing operation on one digital model available under each Pr. No.1, 2 and 3.	CO2
LSO 5.1. Use the available 3D printing software. *LSO 5.2.* Selection of 3D printing process and performance parameters.	5.	Analyse the effect of different process parameters, materials on printing time, material required, surface finish, etc. through simulation using 3D printing software on sliced models available from Pr. No. 4	CO3, CO4, CO5
LSO 6.1. Produce single plastic components using available 3D printer. *LSO 6.2.* Perform post processing operations on printed component.	6.	Print one single component on available 3D printer with PLA/ABS material	CO3, CO4, CO5
LSO 7.1. Select appropriate layer thickness, tolerance, fit. *LSO 7.2.* Produce an assembly of plastic	7.	Print one assembly on available 3D printer with PLA/ABS material	CO3, CO4, CO5

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
components using available 3D printer.			
LSO 8.1. Choose suitable material for printing flexible structure (assembly of same small pieces to give flexible fabric effect). LSO 8.2. Choose suitable design/shape to create a flexible type structure. LSO 8.3. Produce flexible plastic structure using available 3D printer.	8.	Model and print a flexible fabric structure with PLA/ABS material (assembly of same small pieces to give flexible fabric effect)	CO3, CO4, CO5
LSO 9.1. Selection of 3D printing process parameters.	9.	Change printing process parameters and repeat experiment number 6.	CO4, CO5
LSO 10.1. Use of available 3D scanner. LSO 10.2. Develop 3D digital model using scanning approach. LSO 10.3. Modeling of complex 3D objects using 3D scanning.	10.	Scan the given complex component using available 3D Scanner.	CO5
LSO 11.1. Produce a complex plastic structure using available 3D printer and scanner. LSO 11.2. Apply Reverse Engineering approach to exactly 3D print an existing real object.	11.	Print the 3D scanned digital model of Pr. No. 10 on available 3D printer with PLA/ABS material	CO5

L)   Sessional Work/Term Work and Self Learning: [2000511E]

a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. **Micro Projects:**
   1. Perform 3D printing of plastic casing of inhaler used by Asthma patients and estimate the cost.
   2. Download 5 videos on 3D printing of different components, watch them and write a report to detail out the steps involved, 3D Printer used, 3D Printing software used, material used, complexity involved, printing time, post processing steps used.
   3. Print two pieces of same components using ABS and PLA and compare their strength, surface roughness, weight, cost.
   4. Download two 3D printing free software and try to check their compatibility with your lab printer.

c. **Other Activities:**
   1. Seminar Topics:
      • Commercially available 3D printers and software.
      • Strength of 3D printed Plastic components as compared to Die cast Plastic components.
      • Properties of PLA and ABS 3D printing materials.
      • Reverse engineering application of 3D Printing.
   2. Visits: Visit nearby tool room/industry with 3D Printing facilities. Prepare report of visit with special comments of 3D printing technique used, material used, single component/batch production/mass production and cost of printed component.

3. Self learning topics:
    *   3D printing of flexible plastic components.
    *   3D printing of micro/mini components.
    *   Conversion of CAD file formats into IGES.
    *   3D scanning process.

M) **Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	10%	15%	-	-	20%	20%
CO-2	10%	20%	10%	25%	-	10%	20%
CO-3	15%	20%	15%	25%	33%	15%	20%
CO-4	30%	20%	30%	25%	33%	15%	20%
CO-5	30%	30%	30%	25%	34%	40%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*   **:** Other Activities include self learning, seminar, visits, surveys, product development, software development etc.
*   **** **:** Mentioned under point- (N)
*   **#** **:** Mentioned under point-(O)

Note: For CO attainment calculation Indirect assessment tools like Course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Additive Manufacturing Introduction and CAD	CO1	12	4	3	5
Unit-2.0 Data Preparation for 3D Printing	CO1, CO2	10	4	2	4
Unit-3.0 Additive Manufacturing Techniques	CO3, CO4	19	5	5	9
Unit-4.0 Application of 3D Printing	CO3, CO4	10	2	3	5
Unit-5.0 3D Printers and Software and Scanners	CO4, CO5	19	5	5	9
Total Marks		70	20	18	32

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Specification Table for Laboratory (Practical) Assessment:**

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Develop digital models of following simple components using any CAD software: • Nut • Bolt • Network cable Jack • Coat button • Spoon	CO1	30	60	10
2.	Develop digital models of following assemblies using any CAD software: • Connecting Rod • Piston • Electric switch • Bathroom Tap • Mouse	CO1	40	50	10
3.	Download three digital CAD models freely available on web in different formats and then convert them into .stl/obj format.	CO1	30	60	10
4.	Perform slicing operation on one digital model available under each Pr. No.1, 2 and 3.	CO2	30	60	10
5.	Analyse the effect of different process parameters, materials on printing time, material required, surface finish, etc. through simulation using 3D printing software on sliced models available from Pr. No. 4	CO3, CO4, CO5	30	60	10
6.	Print one single component on available 3D printer with PLA/ABS material	CO3, CO4, CO5	30	60	10
7.	Print one assembly on available 3D printer with PLA/ABS material	CO3, CO4, CO5	30	60	10
8.	Model and print a flexible fabric structure with PLA/ABS material (assembly of same small pieces to give flexible fabric effect)	CO3, CO4, CO5	40	50	10
9.	Change printing process parameters and repeat experiment number 6.	CO4, CO5	40	50	10
10.	Scan the given complex component using available 3D Sanner.	CO5	40	50	10
11.	Print the 3D scanned digital model of Pr. No. 10 on available 3D printer with PLA/ABS material	CO5	30	60	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ ImplementationStrategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Parametric Computer Aided Design software	CATIA/Solid works/NX/Creo **OR** Available with CoE	1,2
3.	3D printer	Fused Deposition Modelling system with complete accessories; Build Volume-300 x 300 x 300mm or Higher; Layer Thickness-0.1 – 0.4 **OR** Available with CoE	6, 7, 8, 10
4.	3D Printing Material	ABS/PLA **OR** Available with CoE	6, 7, 8, 10
5.	3D Printing software	Latest version of software like: Cura/PrusaSlicer/ideaMaker/Meshmixer/MeshLab **OR** Available with CoE	3,4
6.	Post processing equipments and tools	Deburring tools (tool handle & deburring blades), Electronic Digital Caliper, Cleaning Needles, Art knife set, Long nose pliers, Flush cutters, Wire brush, Nozzle cleaning kit, Tube cutter, Print removal spatula, Needle file, Cutting mat, Glue stick, Wire stripper etc.	6, 7, 8, 10
7.	3D Scanner and Processing software	Handheld 3D scanner, Accuracy up to 0.1 mm, Resolution up to 0.2 mm, Real time onscreen 3D model projection and processing, Wireless technology with an inbuilt touch screen and battery, Extended field of view for capturing both large and small objects, Processing Software **OR** Available with CoE	10

R) **Suggested Learning Resources:**

(a) **Suggested Books** :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Lan Gibson, David W. Rosen, Brent Stucker	Springer, 2010 ISBN: 9781493921133
2.	Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing	Andreas Gebhardt,	Hanser Publisher, 2011 ISBN: 156990507X, 9781569905074

3.	3D Printing and Design	Sabrie Soloman	Khanna Publishing House, Delhi ISBN: 9789386173768
4.	3D Printing and Rapid Prototyping- Principles and Applications	C.K. Chua, Kah Fai Leong	World Scientific, 2017 ISBN: 9789813146754
5.	Getting Started with 3D Printing: A Hands-on Guide to the Hardware, Software, and Services Behind the New Manufacturing Revolution	Liza Wallach Kloski, Nick Kloski	Make Community, LLC; 2nd edition, 2021 ISBN: 9781680450200
6.	Laser-Induced Materials and Processes for Rapid Prototyping	L. Lu, J. Fuh, Y.S. Wong	Kulwer Academic Press, 2001 ISBN: 9781461514695

(b)   Suggested Open Educational Resources (OER):

1. https://onlinecourses.nptel.ac.in/noc21_me115/preview
2. https://archive.nptel.ac.in/courses/112/104/112104265/
3. https://www.youtube.com/watch?v=b2Od4YHcLAQ
4. https://www.youtube.com/watch?v=EF8CNR-gcXo
5. https://www.academia.edu/41439870/Education_Resources_for_3D_Printing
6. https://www.think3d.in/landing-pages/beginners-guide-to-3d-printing.pdf
7. https://all3dp.com/1/types-of-3d-printers-3d-printing-technology/

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c)   Others: (If any)

1. 3D Printing Projects DK Children; Illustrated edition, 2017
2. The 3D Printing Handbook: Technologies, design and applications Ben Redwood, Filemon Schöffer, Brian Garret, 3D Hubs; 1st edition, 2017
3. 3D Printer Users' Guide
4. 3D Printer Material Handbook
5. Lab Manuals

S)   Course Curriculum Development Team(NITTTR)
- Dr. Sharad Pradhan(Coordinator)
- Dr. A. K. Sarathe(Co-coordinator)

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A)	Course Code	: 2000505 F / 2000508 F /2000511F
B)	Course Title	: Industrial Automation (Basic)
C)	Pre- requisite Course(s)	: Basic Mechanical Engineering, Basic Electrical Engineering, Digital Electronics and Basic programming skills
D)	Rationale	:

The technological education and research scenario, all over the world, is turning towards a multidisciplinary one. The present scenario is different as compared to the recent past in the sense that the engineering disciplines are now dilating instead of diverging. The primary reason being that the current technological designs are of highly complex and inter-interdisciplinary nature involving synergistic integration of many aspects of engineering knowledge base. Industrial automation has become an essential part of every modern industry. Automation helps industry to increase the productivity, quality, accuracy and precision of industrial processes. Stiff competition, higher quality standards and growing concerns of safety & environmental damage have pushed the Industrial sector to adapt state-of-the-art Automation Techniques for effective utilization of resources and optimized performance of the plants. Today engineer is needed to meet the requirements of designing appropriate automation systems. They should have the knowledge of different fields like PLC and PID based Controller, Instrumentation, Networking, Industrial Drives, SCADA/HMI, High speed data acquisition, etc., to become a successful automation engineer. The discipline Automation is enormous in magnitude. The students passing this course will gain basic understanding about industrial automation and will be prepared to take up the advance course in Industrial automation in next semester.

E) Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Apply principles and strategies for automation for a given situation.

CO-2 Use sensors and input devices as per given situation.

CO-3 Test the given PLC for its functionality.

CO-4 Use actuators and output devices as per given situation.

CO-5 Test the working of various types of control system and controllers

F) Suggested Course Articulation Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Dev elopment of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1 Apply principles and strategies for automation for a given situation	3	2	-	2	2	-	2			
CO-2 Use sensors and input devices as per	3	2		2			2			

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
the requirement.			2		-	-				
CO-3 Test the given PLC for its functionality.	3	2	2	2	2	-	2			
CO-4 Use actuators and output devices a per given situation**.**	3	2	2	2	2	-	2			
CO-5 Test the functionality of various types of control system and controllers	3	2	2	2	-	-	2			

Legend: High (3), Medium (2), Low (1) andNo mapping (-)

G)   Scheme of Studies:

CourseCode	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C) (CI+LI+SW+SL)
		L	T				
2000505 F / 2000508 F/ 2000511F	Industrial Automation (Basic)	02	-	04	02	08	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction(Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours:Hours of engagement by learners, other than the contact hours for ensuring learning.

SW: Sessional Work (includesassignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCS,spoken tutorials, open educational resources (OERs)

C: Credits.

Note: SW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) **Scheme of Assessment:**

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PL)	End Laboratory Assessment (ELA)	
2000505F / 2000508F /2000511F	Industrial Automation (Basics)	30	70	20	30	20	30	200

Legend:
PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)
PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)
SWA: Sessional Work/ Term work& Self Learning Assessment (Includes assessment related to student performance in selflearning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.
Note: Separate passing is must for progressive and end semester assessment for both theory and practical.
Theory: 100 marks
Practical 50 marks

I) **Course Curriculum Detailing:**

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes(LSOs) leading to attainmentof Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others need to be integrated.

J)   Theory Session Outcomes (TSOs) and Units: [2000505 F]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1.a Describe Industry 4.0 and its component TSO.1.b Explain different types of automation systems TSO.1.c Identify the type of automation used in a given industry TSO.1.d Analyze the working of industrial processes and products for automation. TSO.1.e Select principles and strategies for automation for a given situation using 4R's and 1U TSO.1.f Select criteria for factory automation and processes automation for a given industry. TSO.1.g Describe briefly different systems used for industrial automation. TSO.1.h Describe IOT, IIOT and role of robots with respect to automation.	**Unit-1.0Overviewof Industrial Automation** Introduction to Industry 4.0 and its components, Issues and challenges in automation Need of automation in industries, Principlesand strategies of automation, factory automation, process automation Basic elements of an automated system, Structure of Industrial Automation Advanced automation functions, Levels of automations Industrial control Systems- Process andDiscrete system Types of automation system: Fixed, Programmable, Flexible IntegratedAutomation and its application Different systems used for Industrial automation: PLC, HMI, SCADA, DCS, Drives. Introduction to Internet of Things (IoT) and Industrial Internet of Things (IIOT) and its application in Automation. Role of robots in automation and its components.	CO1 Apply principles and strategies for automation for a given situation.
TSO.2.a Explain PLC and list its advantages over relay systems. TSO.2.b Distinguish between PLC and a PC, PLC and dedicated controllers. TSO.2.c List the types of PLCs and brands available in the market. TSO.2.d Describe the function of each block of a PLC with the help of a block diagram. TSO.2.e Describe the basic sequence of operation of a PLC with a simple example. TSO.2.f Explain different PLC programming languages with simple examples. TSO.2.g Describe a simple PLC programming using ladder logic specifying I/O addressing TSO.2.h List the applications of PLC	**Unit-2.0Fundamentals of PLC** Introduction to PLC, evolution of PLC • Comparison of PLC and Personal Computer (PC) • Comparison of PLC and dedicated controllers like PAC and CNC • Types of PLC – Fixed, Modular and their types • Different brands of PLCs available in the market Building blocks of PLC -CPU, Memory organization, Input-Output modules (Discreteand Analog) Specialty I/O Modules, Power supply PLC programming languages with simple examples: • Functional Block Diagram (FBD), • Instruction List. • Structured text, • Sequential Function Chart (SFC), • Ladder Programming PLC I/O addressing in ladder logic Simple programming example using ladderlogic Applications of PLC: Traffic light control, Elevator control, Motor sequencing control, Tank level control, temperature control, Conveyor system	CO2 Use sensors and input devices as per given situation.

Major Theory Session Outcomes (TSOs)	Unit s	Relevant COs Number(s)
	control	

TSO.3.a Identify the commonly used input field devices in PLC installations along with their symbols.
TSO.3.b Draw symbol of various switches used in PLC installations describing the function of each switch.
TSO.3.c Identify the various digital input devices used in a PLC installation.
TSO.3.d Identify the commonly used sensors as input field devices found in PLC installations.
TSO.3.e Describe the working of different types of discrete sensors giving their applications.
TSO.3.f Describe the working of different types of advanced sensors giving their applications.
TSO.3.g Select Sensors as per the given requirement for ecofriendly automation
	Unit 3 – Sensors and Input field devices
	Analog input devices-Electromagnetic relays, Contactors, Motor starters,
	Manually operated Switches
	   Toggle switch, pushbutton switch, knife switch andselector switches
	Mechanically operated switches, Limit switch, Temperature switch (Thermostat), Pressure switch, Level switch and their symbols
	Discrete/Digital Input device, Construction and working of Sensors
	   • Proximity sensors- Inductive, Capacitive,Optical and ultrasonic
	Advanced sensors- Construction and workingof
	   • Temperature sensors- Thermistor,Thermocouple and Resistance temperature Detector (RTD)
	   • Liquid level sensor -Capacitive andUltrasonic
	   • Force -Strain/Weight sensors
	   • Flow sensors – turbine flow sensor
	   • Pressure sensors- Linear VariableDifferential Transformer (LVDT)
	   • Inclination sensor -Inclinometer
	   • Acceleration sensor- Accelerometer
	   • Angular and linear position sensor
		CO 3
		Test the given PLC forits functionality

TSO.4.a Classify the actuators.
TSO.4.b Describe the construction and working of a given actuator.
TSO.4.c Explain the basic principle of operation of a given actuator.
TSO.4.d Differentiate between hydraulic and pneumatic actuators
TSO.4.e Explain the basic principle of operation of a given control valve.
TSO.4.f Select actuators and valves as per the given requirement for ecofriendly automation.
TSO.4.g Develop different hydraulic and pneumatic circuits for simple application.
TSO.4.h Identify the commonly used output field devices in PLC installations
TSO.4.i Draw the symbol of various
	Unit 4- Actuators and output devices
	Introduction to actuators, Classification of actuators
	   Mechanical actuators -Translational and rotational motion, kinematic chains,cams, gears, belt and chain drives, bearings
	Hydraulic and Pneumatic actuators- linear and rotary actuators, single and double acting cylinder, directional, process and pressure control valves
	Electrical actuators
	   • Electromechanical actuators Construction, working and application of Stepper motors, AC/DC Servo motors, BLDC Motor (Very brief)
	   • Electrohydraulic actuators- Construction, working and application of Electro- hydrostatic actuator (EHA), ON/OFF Electro-hydraulic Rotary Actuator (E2H90, Control Valve
		CO 4
		Use actuatorsand output devices as per given situation**.**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	4.6 Magnetic actuators- Construction, working principle and application of Moving coil actuators, moving magnet actuator, Moving iron actuator Selection criteria of actuators Other Output devices- Indicators, Alarms Pilot Lights, Buzzers, Valves, Motor starters, Horns and alarms, Stack lights Control relays,Pumps and Fans.	
TSO.5.a Describe the basic process control system with the help of a block diagram TSO.5.b Explain the types of control available in a process control TSO.5.c Describe the different types of controllers in a closed loop system with the help of a block diagram TSO.5.d Describe the construction, working and application of a given control system components.	**Unit 5– Control system** Block diagram of a basic control system Open and closed loop system, their transfer function First order and second order system and their output response and parameters Different types of inputs-step and ramp Types of control – On-off, Feed forward, Open loop and closed loop control and Transfer function Controllers in closed loop control • Proportional Controller(P Controller) • Integral Controller (I Controller) • Derivative controller (D- Controller) • P-I Controller • P-D Controller • PID Controller	**CO5** Test the working of various types of control system and controllers

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508 F]

Practical/Lab Session Outcomes (LSOs)	S.No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 Identify various building blocks and major automation components in a given robotic system LSOs 1.2 Identify various building blocks and major automation components in a given electrical drives	1.	Identify major automation components in a given system	**CO1**
LSOs 1.3 Analyze and plan the steps to automate the given system.	2.	Analyze given traditional machine in the laboratory for and identify the steps and components required to automate it.	
LSO 1.4. Identify the building blocks of a given typical SCADA system LSO 1.5. Identify the symbol library of SCADA software	3.	Use Scada software for simple application	
LSOs 2.1 Identify the various parts and front panel status indicators of the given PLC.	4.	Observe various parts and front panel indicators of a PLC	**CO2**

LSOs 2.2 Identify different input and output devices that can be connected to a given PLC.	5.	Observe different types of switches and their symbols sensors, lamp, alarm, motor, fan used in a PLC	
LSOs 2.3 Test the analog input and output lines of the given PLC.	6.	Identify Analog input and output lines of a PLC	
LSOs 2.4 Test the digital input and outlines of the given PLC.	7.	Identify digital input and output lines of a PLC	
LSOs 2.5 Use PLC to control the devices like Lamp, Alarm, motor using push button switches	8.	Practice using PLC to control various digital and analog output devices	
LSO 3.1. Test the response of digital inductive proximity sensorused to detectdifferent types of materials	9.	Identify different types of digital inductive proximity sensor and its use	CO3
LSO 3.2. Test the response of digital capacitive proximity sensors used to detect o different materials	10.	Identify different types of digital capacitive proximity sensor and its use	
LSO 3.3. Test the response of digital optical proximity sensor used to detect different materials	11.	Identify different types of digital optical proximity sensor and its use	
LSO 3.4. Test the response of digital ultrasonic proximity sensors used to detect different materials	12.	Identify different types of digital ultrasonic proximity sensor and its use	
LSO 3.5. Use thermistor to measure temperature of a given material	13.	Identify different types of thermistor and its use	
LSO 3.6. Use Thermocouple to measure the temperature of a given liquid and plot the output voltage versus temperature	14.	Observe the conversion of temperature to electric parameter conversion of a Thermocouple	
LSO 3.7. Use RTD to control the temperature of an oven	15.	Observe different types of RTDs used in industries for temperature measurement	
LSO 3.8. Use flow sensors to measure the flow of a given liquid or gas	16.	Observe different types of flow sensors used in industries for flow measurement	
LSO 3.9. Use pressure sensors to measure the pressure of a liquid or gas	17.	Observe different types of pressure sensors used in industries for pressure measurement	
LSO 3.10. Use load cell for measurement of mechanical force/weight.	18.	Observe the different types of load cell used in industries for force/weight measurement	

LSOs 4.1 Design and actuate pneumatic circuit for lift control LSOs 4.2 Design a pneumatic system that rivets the pockets on jeans LSOs 4.3 Design pneumatic circuit to open and close the security gate and control the speed. LSOs 4.4 Design a circuit for speed control of hydraulic motor meter out circuit by using 4/3 DC valve. LSOs 4.5 Design a circuit for speed control of double acting cylinder meter in by using 4/2 dc solenoid valve. LSOs 4.6 Designing a circuit for speed control of double acting cylinder meter out by using 4/3 solenoid valve	19.	Design and actuate pneumatic/ hydraulic circuit for the given situation	
LSOs 4.7 Direct acting of hydraulic motor	20.	Operate hydraulic motor	
LSOs 4.8 Operate stepper motor and control the motor by changing number of steps, the direction of rotation and speed.	21.	Operate stepper motor	
LSOs 4.9 Identify the components of thermal and magnetic actuators available in the laboratory. LSOs 4.10 Use thermal and magnetic actuators	22.	Thermal and magnetic actuators	
LSOs 5.1 Test the output response of a open loop closed loop and feed forward path	23.	Analyze the given system to study open loop, closed loop and feed forward path.	CO5
LSOs 5.2 Build and test the output response of a first order system for a step input using a CRO	24.	Analyze the given first order system and its transfer function and output response	
LSOs 5.3 Build and test the response of a second order system for a step input usingCRO.Also mark various parameters	25.	Analyze the given second order system and its transfer function and output response	
LSOs 5.4 Test the Output response of an on-off and Proportional control-based level control system.	26.	Analyze the given water level control system with on-off, Proportional control.	
LSOs 5.5 Test the Output response pf a P+I+D based level control system.	27.	Analyze the given water level control system with P+I+D control.	

L) Sessional Work and Self Learning: [2000511 F]

    a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

      i. State three advantages of using programmed PLC timer over mechanical timing relay.

      ii. Prepare a list of open source PLC software

iii. Prepare a list of open source SCADA software.

iv. List the practical applications of PLC systems

v. List the practical applications of SCADA systems.

vi. Compare the PLC and PC with regard to:
- Physical hardware differences
- Operating environment
- Method of programming
- Execution of program

vii. Prepare classification chart of different types of actuators.

viii. Differentiate between Nano and micro actuators.

b. Micro Projects:

1. Develop a relay-based motor control automation such that the motor reverses its direction when the limit switches are activated.
2. Develop a simulation to connect analog and digital input to the PLC.
3. Develop a simulation to connect analog and digital output to the PLC.
4. Develop a simple automatic water level controller using magnetic float switch.
5. Develop a simple automatic door system using optical sensor and linear actuator.
6. Troubleshoot the faulty equipment/kit available in automation laboratory
7. Select one industry and analyze the process and propose the automation strategies' that can be used for automation.
8. Develop a working model of a given application using given actuators and valves.

c. Other Activities:

1. Seminar Topics- PLC architecture, Different types of sensors, Industrial Applications of PLC and SCADA
2. Visits – Visit any industry with full or semi automation and prepare a report on type of automation used.
3. Surveys-Carry out a market/internet survey of PLC and prepare the comparative technicalspecifications of any one type of PLC (Micro or Mini) of different manufacturer.
4. Product Development- Develop a prototype automatic railway crossing system

Software Development- Download any open source software for PLC and install on your laptop/PC and carry out basic PLC programming

5. Surveys – carry out market survey for different types of electrical actuators available and prepare the comparative technical specifications of electrical actuators used in industries.
6. Visit industry and prepare a report on different types of hydraulic and pneumatic circuits used by the industry in the given section, components used, power requirement, output achieved and maintenance activities required.

d. Self-learning topics:

1. Use of PLC for different industrial applications
2. Use of sensors in commercial field
3. Use of sensors in home automation
4. Compare Specifications of PLCs of different manufacturers of any one type PLC

M) **Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. There sponse/performance of the student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Scheme of Assessment (Marks)								
	Theory Assessment (TA)					Lab Assessment (LA)			
	Progressive Theory Assessment (PTA)# Class/Mid Sem Test	End Theory Assessment (ETA)**	Sessional Work & Self Learning Assessment (SWA)			Progressive Lab Assessment (PLA)			End Laboratory Assessment (ELA)#
			Assignments(s)	Micro Projects	Other Activities*	Process Assessment (PRA)	Product Assessment (PDA)	Viva-Voce	
CO-1	15 %	20%	20 %	100	10 %	45%	35 %	100%	20 %
CO-2	20 %	20%	20 %		15 %	45%	35 %		20 %
CO-3	25 %	20%	20 %		15 %	45%	35 %		20 %
CO-4	25 %	20%	20 %		30 %	45%	35 %		20 %
CO-5	15 %	20%	20 %		30 %	45%	35 %		20 %
Total Marks	20	70	4	4	2	8	8	4	30

Legend:
* : Other Activities include seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
: Mentioned under point-(O)
Note: To calculate CO attainment 80% weightage of direct assessment tools and 20% of indirect assessment tools may be taken.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weight age in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Overview of Industrial Automation	CO1	12	4	6	4
Unit-2.0 Fundamentals of PLC	CO2	17	5	6	6
Unit-3.0 Sensors and Input field devices	CO3	16	4	6	6
Unit-4.0 Actuators and output devices	CO4	15	4	5	6
Unit- 5.0 Control system	CO5	10	3	4	4
Total Marks		70	20	27	26

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Specification Table for Laboratory (Practical) Assessment:**

S.NO	Laboratory Practical Titles	Relevant COs Number(s)	PLA #/ELA # (Marks)		
			Performance		Viva-Voce
			PRA (45%)	PDA (45%)	(10 %)
1.	Identify major automation components in a given system	CO1	45 %	35 %	20%
2.	Analyze given traditional machine in the laboratory for and identify the steps and components required to automate it.	CO1	45 %	35 %	20%
3.	Use Scada software for simple application	CO1	45 %	35 %	20%
4.	Observe various parts and front panel indicators of a PLC	CO2	45 %	35 %	20%
5.	Observe different types of switches and their symbols sensors, lamp, alarm, motor, fan used in a PLC	CO2	45 %	35 %	20%
6.	Identify Analog input and output lines of a PLC	CO2	45 %	35 %	20%
7.	Identify digital input and output lines of a PLC	CO2	45 %	35 %	20%
8.	Practice using PLC to control various digital and analog output devices	CO2	45 %	35 %	20%
9.	Identify different types of digital inductive proximity sensor and its use	CO3	45 %	35 %	20%
10.	Identify different types of digital capacitive proximity sensor and its use	CO3	45 %	35 %	20%
11.	Identify different types of digital optical proximity sensor and its use	CO3	45 %	35 %	20%
12.	Identify different types of digital ultrasonic proximity sensor and its use	CO3	45 %	35 %	20%
13.	Identify different types of thermistor and its use	CO3	45 %	35 %	20%
14.	19. Observe the conversion of temperature to electric parameter conversion of a Thermocouple.	CO3	45 %	35 %	20%
15.	Observe different types of RTDs used in industries for temperature measurement	CO3	45 %	35 %	20%
16.	Observe different types of flow sensors used in industries for flow measurement	CO3	45 %	35 %	20%
17.	Observe different types of pressure sensors used in industries for pressure measurement	CO3	45 %	35 %	20%
18.	Observe the different types of load cell used in industries for force/weight measurement	CO3	45 %	35 %	20%
19.	Design and actuate pneumatic/ hydraulic circuit for the given situation	CO4	45 %	35 %	20%
20.	Operate hydraulic motor	CO4	45 %	35 %	20%
21.	Operate stepper motor	CO4	45 %	35 %	20%
22.	Thermal and magnetic actuators	CO4	45 %	35 %	20%
23.	Analyze the given system to study open loop, closed loop and feed forward path.	CO5	45 %	35 %	20%
24.	Analyze the given first order system and its	CO5	45 %	35 %	20%

S.NO	Laboratory Practical Titles	Relevant COs Number(s)	PLA # /ELA # (Marks)		
			Performance		Viva-Voce (10 %)
			PRA (45%)	PDA (45%)	
	transfer function and output response				
25.	Analyze the given second order system and its transfer function and output response	CO5	45 %	35 %	20%
26.	Analyze the given water level control system with on-off, Proportional control.	CO5	45 %	35 %	20%
27.	Analyze the given water level control system with P+I+D control.	CO5	45 %	35 %	20%

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubricsneed to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and CommunicationsTechnology(ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	SCADA software (reputed make like Allen Bradley, Siemens etc.,)	Ready-to-use symbol library, React and respond in real-time, Real time monitoring, Friendly, manageable, secure, extensible, Easy-to-use, easy to implement, Easy configuration, simplified maintenance, Communication with PLC, easy and flexible alarm definition, data collection and analysis for new and existing systems, easy-to-use for report generation, open access to historical data, different packages available with input/output structure. Open source software SCADA software: like Ellipse/FTVSE/Wonderware/ open SCADA can also be used	3
2.	Universal PLC Training System with HMI (Of reputed make such as Allen bradely, Siemens, etc.,) Compatible with SCADA software	Human Machine Interface (HMI) display, PLC with 16 digital inputs, 16 digital outputs with RS232 communication facility. Open platform to explore wide PLC and HMI applications. Industrial look & feel. Toggle switches, push to ON switch, proximity sensor, visual indicator, audio indicator, and DC motor. Experiments configurable through patch board. Powerful instruction sets. Several sample ladder and HMI programs. PC based ladder and HMI programming. Extremely easy and student friendly software to develop different programs. Easy downloading of programs. Practice troubleshooting skills. Compact tabletop ergonomic design. Robust construction. PLC gateway for cloud connectivity. Open source software like Ladder logic simulator, Pico soft Simulator, Logixpro simulator, Simple EDA tools can also be used	4,5,6,7,8

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
3.	Proximity sensors kit	The kit should comprise of the following proximity sensor - Inductive Proximity Sensor, Capacitive Proximity Sensor, Magnetic Sensor, Optical Sensor, Audio and LED indicator for the object detection. Along with learning material	9,10,11,12
4.	Temperature transducer kit	Temperature Transducers Test Bench includes different types of temperature sensors including bimetallic strip, RTD, thermocouple, thermistor, RTD/thermocouple temperature display and thermistor, temperature display, heater, fan, switches and its indicator.Separate heater and fan chamber with stand. On panel digital voltmeter, digital ammeter, RTD/thermocouple temperature display, NTC temperature display, toggle switch for heater and fan with indicator, experiments configurable through patch board, heavy duty Test bench, castor wheel (with locking mechanism) is provided at legs of Test bench so that it can be easily moved, enhanced electrical safety consideration.	12,13,14
5.	Pressure transducer kit	Pressure transducer kit should include different types of pressure sensors including capacitive pressure transducer, load cell, bourdon tube pressure gauge, and pressure vessel.Pressure vessel with pressure gauge, safety valve, non returning valve bourdon gauge and capacitive transducer and air compressor, on panel digital voltmeter, digital ammeter, 4-20ma display, 0-10V DC display, toggle switch for compressor, load cell with suitable weight, experiments configurable through patch board, self -contained, bench-mounting arrangement, castor wheel (with locking mechanism) is provided at legs of Test bench so that it can be easily moved, enhanced electrical safety consideration. Detailed experiment manual should be supplied with the kit.	16
6.	Flow sensor kit	Turbine flow sensor kit	15
7.	Strain Gauge kit	The kit should provide study of Strain Gauge and their application for measurement of Strain. It should help to study bridge configuration of Strain Gauge and the signal conditioning circuits required to measure strain. It should use cantilever beam arrangement to produce strain on Strain Gauge.The Strain Gauges are firmly cemented to the cantilever at the point where the strain is to be measured. Weights are placed on free end of cantilever. Strain developed changes the resistance of Strain Gauge which is detected by full bridge configuration. It should comprise of Seven-segment LED display showing strain in micro strain units. Different weights should be provided to perform linearity and sensitivity experiments. Detailed experiment manual should be supplied with the kit. Test-points to observe input output of each block, onboard gain and offset null adjustment, built in DC Power Supplies, 3½ digits LED display, onboard Cantilever arrangement, high repeatability and reliability The kit should be capable of performing following experiments: - Measuring strain using strain gauges and cantilever assembly. - Determination of linear range of operation of strain measurement. - Determination sensitivity of the kit	17
8.	Cut sections of pumps, actuators, valves and	Suitably cut and mounted on a sturdy base to show the internal details.	18

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
	accessories used in hydraulic systems		
9.	Working models of pumps, actuators, valves and accessories used in hydraulic systems	Working models mounted on sturdy base to demonstrate the operation.	18
10.	Working models of pumps, actuators, valves and accessories used in pneumatic systems	Working models mounted on sturdy base to demonstrate the operation.	18
11. 8	Oil Hydraulic trainer	Mounted on sturdy base fitted with all standard units and accessories to create various hydraulic circuits. Hydraulic trainer with simulation software Pneumatic trainer with simulation software • Filter Regulator Combination with Lubricator (FRL Unit) with pressure gauge , Junction Box with slide valve, Push Button Valve , 3/2 NC Roller lever valve ,3/2 NC Roller lever valve ,5/2 Double external pilot operated valve, 5/2 External pilot operated valve with spring return , 5/2 Hand lever with spring return, 5/2 Hand lever valve with detent – for maintained pilot operation of a SAC , 5/2 Valve with Lever head, 5/2 Value with Mushroom head , Flow control valve – Metering IN & OUT , Shuttle Valve (OR valve) , Quick Exhaust Valve with Quick coupler plug • Double Acting Cylinder (DAC) with Quick coupler socket (with accessories: Screw driver – for cushioning adjustment), Single Acting Cylinder (SAC), Swivel fitting assembly with Quick coupler plug, Multi distributor fittings (for cascading circuit designing) • Single Solenoid Valve with Spring Return (with LED), Double Solenoid Valve (with LED), Magnetic Reed Switch, Magnetic Reed Switch, Relay Logic Unit – 2C/0-3 relays, Electrical Push Button Unit, Electrical Selector Switch Unit, Timer	18
12.	Pneumatic Trainer	Mounted on sturdy base fitted with all standard units and accessories to create various Pneumatic circuits. Pneumatic trainer with simulation software • Filter Regulator Combination with Lubricator (FRL Unit) with pressure gauge, Junction Box with slide valve • Push Button Valve, 3/2 NC Roller lever valve, 3/2 NC Roller lever valve, 5/2 Double external pilot operated valve (Memory valve) • 5/2 External pilot operated valve with spring return, 5/2 Hand lever with spring return, 5/2 Hand lever valve with detent, 5/2 Valve with Lever head ,5/2 Value with Mushroom head, Flow control valve, Shuttle Valve (OR valve), AND valve • Quick Exhaust Valve with Quick coupler plug, Double Acting Cylinder (DAC) with Quick coupler socket, Single Acting Cylinder (SAC), Swivel fitting assembly with Quick coupler plug • Aluminum Profile Table Top, Profile Table Top, Miniature Double Acting Cylinder (DAC), Single Solenoid Valve with Spring Return, Double Solenoid Valve (with LED) • Magnetic Reed Switch, Relay Logic Unit – 2C/0-3 relays, Electrical Push Button Unit, Electrical Selector Switch Unit (Black Selector – 1 no, Green Push Button – 1 no), Timer, Simulation software	18

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
13.	Advanced Electro - Hydraulic and Electro - Pneumatic Hardware systems with work stations and simulation software	• Electro - Hydraulic and Electro - Pneumatic Hardware systems with PLC and simulation software • Profile plate, Frame with Castor Wheels, Filter, Lubricator, Regulator with pressure gauge, Hand Slide Valve, Connection component set, Plastic Tubing, Power Supply & cables, Pressure Gauge, 3/2 Way double solenoid valve	18
14.	Output devices	Servomotor, DC motor, AC motor, stepper motor, Conveyer Belt control by PLC, water level control etc.	18,19,20
15.	Thermal actuators	Hot-And-Cold-Arm Actuators, Chevron-Type Actuators	21
16.	Magnetic actuators	Moving Coil Controllable Actuators, Moving Iron Controllable Actuator	21
17.	Open and closed loop control system kit	Open and closed loop system kit should be able to measure the output response using CRO	22
18.	First and second order control system	First and second order system with input and output terminals provision	23,24
19.	Process control system with feed forward path kit	Process control system with feed forward path kit with input and output terminals provision	22
20.	PID Controller Test Bench	PID Controller Test Bench is a complete setup to control process through two-point (on/off) and three-point (PID) controllers. Industrial PID controller with RS485 communication facility, Thermocouple temperature sensor, Float switch for detection of water level, Temperature measurement and control, User friendly software, USB Interface, Heavy duty Test bench, Electrical control panel, Leak proof sturdy piping and tanks, SS Sump tank for inlet and outlet of water, Enhanced electrical safety considerations, Caster wheel (with locking mechanism) at the legs of Testbench for easy movement.	25,26

R) Suggested Learning Resources:

(a) Suggested Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Programmable Logic Controllers	Dunning, G.	Thomson /Delmar learning, New Delhi, 2005, ISBN13: 9781401884260
2.	Programmable Logic Controllers	Petruzella, F.D.	McGraw Hill India, New Delhi, 2010, ISBN: 9780071067386
3.	Programmable Logic Controllers	Hackworth, John; Hackworth, Federic	PHI Learning, New Delhi, 2003, ISBN: 9780130607188
4.	Industrial automation and Process control	Stenerson Jon	PHI Learning, New Delhi, 2003, ISBN: 9780130618900
5.	Programmable Logic Controller	Jadhav, V. R.	Khanna publishers, New Delhi, 2017, ISBN: 9788174092281
6.	Programmable Logic Controllers and Industrial Automation - An introduction,	Mitra, Madhuchandra; Sengupta, Samarjit,	Penram International Publication, 2015, ISBN: 9788187972174
7.	Control System	Nagrath & Gopal	New Age International Pvt Ltd, ISBN: 9789386070111, 9789386070111
8.	Linear Control Systems with MATLAB Applications, Publisher:	Manke, B. S.	Khanna Publishers, ISBN: 9788174093103, 9788174093103
9.	Supervisory Control and Data Acquisition	Boyar, S. A.	ISA Publication, USA, ISBN: 978-1936007097
10.	Practical SCADA for industry,	Bailey David ; Wright Edwin	Newnes (an imprint of Elsevier), UK 2003, ISBN:0750658053

(b) **Suggested Open Educational Resources (OER):**

1. Process Automation Control- online Tutorial: www.pacontrol.com
2. PLC product: www.seimens.com
3. www.ab.rockwellautomation.com
4. PLC product: www.abb.co.in
5. Different product of PLC and Peripherals, Smart Tile CPU Board, All in one lighting energycontroller, Classic PLC www.triplc.com
6. Simulation software:http://plc-training-rslogix-simulator.soft32.com/free-download/
7. Simulator :www.plcsimulator.net/
8. https://www.youtube.com/watch?v=y2eWdLk0-Ho&list=PLln3BHg93SQ_X5rPjqP8gLLxQnNSMHuj-
9. https://www.youtube.com/watch?v=86CrhxgAKTw

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c) **Others: (If any)**

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

S) **Course Curriculum Development Team(NITTTR)**
- Dr. Vandana Somkuwar(Coordinator)
- Dr. C. S. Rajeshwari(Co-coordinator)

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**

			:	2000505G / 2000508G / 2000511G
A)	Course Code		:	2000505G / 2000508G / 2000511G
B)	Course Title		:	Electric Vehicle (Basic)
C)	Prerequisite Course(s)		:	
D)	Rationale		:	

Fossil fuel consumption and its adverse impact on the environment have led most nations in the world to adopt electric vehicles for mobility. Most automobile companies are switching from internal combustion engines to electric, a cleaner, and more sustainable alternative. But, in the present scenario, the automobile industries are facing a shortage of skilled technicians needed for the transition to electric drives as the primary source of motive power. There is a huge skill gap between industry and academia when it comes to the task of taking the entire automobile industry towards electric mobility. Therefore, this basic course on an electric vehicles is included in the curriculum of the diploma programme as an open elective course to fill this gap and gain a basic understanding of the importance and necessity of electric vehicles. This course tends to enable participants with multidisciplinary exposure and give them a brief idea about electric vehicles, and their importance. This course gives some basic technical foundations regarding electric vehicles to help them move on to advanced electric vehicle courses.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of the following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the student will be able to-

CO-1 Classify the EVs based on configurations.

CO-2 Identify relevant Motors for the given EV application.

CO-3 Test the performance of batteries used for EV applications.

CO-4 Distinguish between the EV Charging stations based on their Configurations.

CO-5 Follow regulatory requirements and policies for EV Industry.

F) **Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)(if any)		
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1 Classify the EVs based on configurations	3	2	-	2	2	-	3			
CO-2 Identify relevant Motors for the given EV application.	3	2	2	2	2	1	3			
CO-3 Test the performance of batteries used	2	2	3	3	2	2	3			

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)(if any)		
	PO-1 Basic and Discipline-Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
for EV applications										
CO-4 Distinguish between the EV Charging stations based on their configurations	2	2	1	2	2	1	2			
CO-5 Follow regulatory requirements and policies for EV Industry.	1	1	-	-	3	1	2			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) Scheme of Studies:

CourseCode	Course Title	Scheme of Studies (Hours/Week)					
		Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
		L	T				
2000505G / 2000508G / 2000511H	Electric Vehicles (Basic)	02	-	04	02	08	05

Legend:

CI: Classroom Instruction (Includes different instructional/ implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem-based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances in the laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

SW: Sessional Work/Term work (includes assignments, seminars, micro-projects, industrial visits, any other student activities, etc.)

SL: Self-Learning, MOOCs, Spoken Tutorials, Open Educational Resources (OERs)

C: Credits= (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: SW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of the teacher to ensure the outcome of learning.

H)   Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)						Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)		
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
2000505G / 2000508G / 2000511G	Electric Vehicles (Basic)	30	70	20	30	20	30	200

Legend:
PTA: Progressive Theory Assessment in the classroom (includes class test, mid-term test and quiz using online/offline modes)
PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)
SWA: Sessional Work/Term work& Self-Learning Assessment (Includes assessment related to student performance in self-learning, assignments, Seminars, micro-projects, industrial visits, any other student activities etc.
Note: Separate passing is a must for progressive and end-semester assessment for both theory and practical.

I)   Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at the course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes(LSOs) leading to the attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020-related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others must be integrated appropriately.

J)   Theory Session Outcomes (TSOs) and Units: [2000505G]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)

TSO 1a. Identify the types of the vehicle based on the physical features, specification data and information.
TSO 1b. State the advantages of EVs over Conventional IC Engine Vehicles.
TSO 1c. Identify different components of Electric Vehicle systems
TSO 1d. Explain the functions of different components of the EV
	Unit-1.0Introduction to Electric Vehicle
	Review of Conventional Vehicle Engine System
	Electric Vehicle (EV)
	• The necessity of Electric Vehicle
	• Types of Electric Vehicles
	  - Plug-in hybrid
	  - Battery electric vehicle
	  - Hybrid electric vehicle
	  - Fuel Cell Electric Vehicle
	• Advantages of Electric Vehicles
	Electric Vehicle Components: Motor, Motor Controller, Battery, Battery Management System, and Charging System.
		CO1

TSO 2a. Explain the general characteristics of motors used in EV TSO 2b. List different types of motors used in EV TSO 2c. Explain the working principles of motors used in	**Unit-2.0 Electric Motors used in EVs** Electric Motors for EV applications • General Characteristics of motors • Types of Motors: DC, Brushless DC,	CO2

Major Theory Session Outcomes (TSOs)		Units	Relevant COs Number(s)
	EV applications	Induction, Permanent Magnet Synchronous Motors, Switched Reluctance Motors	
TSO 2d.	Interpret the nameplate ratings of the motors for EV applications.		
TSO 2e.	Explain the motor selection criteria for particular EV applications.	Rating of Motors Selection Criteria	
TSO 2f.	Describe the Mechanical and Electrical Connections of Motors.	Physical Location Connection of Motors: Mechanical Connections and Electrical Connections	
TSO 3a.	List the batteries used in EVs for energy storage	**Unit- 3.0 EV Batteries and Energy Storages**	CO3
TSO 3b.	State various parameters related to batteries used in EV applications.	Types of Batteries: Lead Acid, Nickel Based, Lithium Based	
TSO 3c.	Explain the charging and discharging process of the given batteries.	Battery Parameters Charging (AC) and Discharging(DC) Process	
TSO 3d.	Explain the salient features of Lithium Ion batteries	Lithium Ion Batteries	
TSO 3e.	Explain the Fuel Cell Storage System.	Fuel Cells, Fuel Cell Storage System	
TSO 3f.	Identify various sensors installed for monitoring Battery condition.	Battery Condition Monitoring Battery Management System (BMS)	
TSO 3g.	Explain Battery Management System in EV using Block Diagram.	• Need of BMS • Block Diagram of BMS	
TSO 3h.	Describe the procedure of battery Disposal and Recycling	Battery Disposal and Recycling	
TSO 4a.	Identify different types of diodes and transistors.	**Unit- 4.0 EV Charging Systems** Power electronics in EV	CO4
TSO 4b.	Describe the testing procedure for the given Diode and Transistor.	• Power electronics components • Rectifiers	
TSO 4c.	Explain the working principles of the given power electronic converter circuit.	• DC to DC Converter • DC to AC Converter	
TSO 4d.	Describe the types of Charging Systems	Charging System	
TSO 4e.	Describe different Components of the Charging System	• Types of charging Systems • Components of Charging Systems	
TSO 4f.	Explain the working of the Charging System using a single-line diagram.	• Single line Diagram of Charging System	
TSO 5a.	Understand the Rules and Regulations set by the Government for selecting and manufacturing various components of an electric vehicle.	**Unit- 5.0 Regulatory Requirements and Policies for EV Industry** Rules and Regulations set by the Indian government for the designer/manufacturer of EVs.	CO5
TSO 5b.	Understand the Policies for E-Vehicles.	Policies in India	
TSO 5c.	Appreciate the importance of the reduction of greenhouse gases in the environment.	Global Policies for E- Vehicles. Carbon Footprint Issues	

Note: One major TSO may require more than one Theory session/Period.

K)   Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508G]

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.1	Use the relevant digital meter for the given application.	1.	• Practice using digital meters such as AC, DC Clamp Meters, Digital Multimeters, Lux Meters, etc.	CO1
LSO 2.2	Use a measuring instrument for the given application.		• Practice using Screw Driver Kit, Vernier	
LSO 2.3	Use safety kits while working in the			

Practical/Lab Session Outcomes (LSOs)		S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
	laboratory.		Caliper, Micrometer, Ampere Meter, Voltage Meter, and Techno-meter. • Practice using safety kits.	
LSO 2.1	Identify the motors used in EV applications	2.	• Identification of motors used in EVs	CO2
LSO 2.2	Identify the given motor terminals			
LSO 3.1	Identify the batteries available in the laboratory.	3.	• Testing of Batteries used in EVs	CO3
LSO 3.2	Measure an open circuit voltage of the given battery.			
LSO 3.3	Determine the Ampere -Hour Capacity of the given battery with a given load.			
LSO 3.4	Test the performance of the given battery with different charging rates and at different ambient temperatures			
LSO 3.5	Demonstrate the effect on the state of health of the battery after several charge/ discharge cycles.			
LSO 3.6	Evaluate the temperature cut-off point for the given BMS.		• Battery Management System	
LSO 4.1	Identify the Electrical & Electronics components available in the laboratory using Digital Multimeters.	4.	• Power electronic circuits	CO4
LSO 4.2	Test the given power electronic components using digital meters			
LSO 4.3	Identify the given Power Electronic Circuits used in EVs			
LSO 4.4	Identify the components of the Charging System		• Identification of Charging systems	
LSO 4.5	Recognize the types of Charging Systems available in the Laboratory			

L)   Sessional Work and Self-Learning: [2000511G]

   a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

   b. Micro Projects:
   1. Collect the information related to the performance of different types of electric vehicles and prepare a comparative report on economic and environmental analysis.
   2. Collect specifications of different EVs available in the market.
   3. Build and test a prototype circuit of converters used in an electric vehicle.
   4. Visit a nearby Electric vehicle showroom or service centre & collect information on different types of motors used in electric vehicles and prepare a comparative report on their performance,
   5. Visit a nearby charging station and prepare a report describing the layout and components of the charging station.

c.Other Activities:
   1. Seminar Topics:
      • Communication Systems, Sensors and batteries used in Evs.
      • Technological advances in Evs
      • Comparison of EVs manufactured by different companies.
   2. Surveys – Survey the market and gather information on the electric vehicle manufacturers and submit the report.
   3. Product Development- Develop an electric vehicle prototype using locally procured hardware components.
d.   Self-learning topics:
      • Global Manufacturers of EV
      • Indian Manufacturers of EV

- Motors used in EV
- Batteries used in EV
- Cost comparison of EVs in market

M) **Course Evaluation Matrix:** The course teacher has to decide and use the appropriate assessment strategy and its weightage, in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be used to calculate **CO attainment.**

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	10%	10%	20%	--	33%	10%	20%
CO-2	15%	10%	20%	--	33%	15%	20%
CO-3	15%	30%	20%	--	34%	15%	20%
CO-4	30%	30%	20%	50%	--	30%	20%
CO-5	30%	20%	20%	50%	--	30%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*:   Other Activities include seminars, visits, surveys, product development, software development etc.
**:   Mentioned   under
point#: Mentioned under
point
Note: For CO attainment calculation, Indirect assessment tools like Course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use the appropriate assessment strategy and its weightage, in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Title and Number	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Introduction to Electric Vehicle	CO1	12	3	5	4
Unit-2.0 Electric Motors used in EVs.	CO2	15	4	6	5
Unit- 3.0 EV Batteries and Energy Storages.	CO3	20	5	9	5
Unit- 4.0 EV Charging Systems	CO4	15	5	6	4
Unit- 5.0 Regulatory Requirements and Policies for EV Industry	CO5	8	3	3	3
Total Marks		70	20	29	21

Note: Similar table can also be used to design class/mid-term/ internal question papers for progressive assessment.

O)   Specification Table for Laboratory (Practical) Assessment:

S. N.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA Performance PRA (%)	PLA/ELA Performance PDA (%)	Viva-Voce (%)
1	Practice using digital meters such as AC, DC Clamp Meters, Digital Multimeters, Lux Meters, etc.	CO1	30	-	20
2	Practice using Screw Driver Kit, Vernier Caliper, Micrometer, Ampere Meter, Voltage Meter, and Techno-meter.				
3	Practice using safety kits.				
4	Identification of motors used in EV	CO2	15	40	30
5	Testing of Batteries used in EVs	CO3	15	40	30
6	Battery Management System	CO3			
7	Power electronic circuits	CO4	40	20	20
8	Identification of Charging systems	CO4			

Note: This table can be used for both the end semester as well as progressive assessment of practicals. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student's performance.

P)   Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Labs, and Field, Information and Communications Technology (ICT)Based, Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q)   List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	AC, DC Clamp Meters	Application: Non-contact AC/DC Voltage and Current measurement **AC Application:** Current: 0-200Amp, Voltage: 0-600Volt **DC Application:** Current: 4-20mA, Voltage: 0-30Volt.	1
2.	Digital Multimeters	Display: 4 ½ digit Indications: overload protection, polarity indication, over range indication. Auto range change and auto polarity change facility, auto display of polarity and decimal point. **DC**: Volt: 200mV-600V, Current: 200mA-2A **AC**: Volt: 200mV-1000V, Current: 200mA-2A Resistance: 200W-20mW, Power supply: 230V, 50Hz Battery operation: 9 Volt battery Electronic components testing facility should be provided in the Multimeter. A provision for an A.C. adaptor(eliminator) must be available along with the multimeter.	1, 3
3.	Lux Meters	Functions: MAX / MIN, Backlight, Auto Power Off Range: 0 ~ 200,000 lux 0 ~ 20,000 fc Accuracy: ± 5% rdg + 10 dgt (< 10.000 lux / fc) ± 10% rdg +	1

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
		10 dgt (>10.000 lux / fc) Resolution: 0.1 lux or 0.1 fc Accessories: Carrying Case, Installation Manual, 9V Battery (installed).	
4.	Screw Driver toolbox	All types of screw drive sets.	1
5.	Vernier Caliper	**Range:** Lower scale: 0-200mm, Upper Scale: 0-12inch **Vernier Resolution:** Lower Scale: 0.02mm, Upper Scale: 0.001inch	1
6.	Micrometer	0-25mm (inside/outside)	1
7.	Ampere Meter	Moving iron and Moving Coil	1
8.	Voltmeter	AC(0-250V)/DC(0-24V)	1
9.	Tachometer	For speed measurement (0-3000rpm)	1
10.	Resistors	Low-value Resistors of different types	1,4
11.	Capacitors	Low-value electrolyte Capacitors.	1,4
12.	Inductors	Low-value inductors.	1,4
13.	Safety Kit	First Aid Kit, Helmet, Face Mask, Gloves etc.	1
14.	Motors for Electric Vehicle application	Brushless DC, Induction, Permanent Magnet Synchronous Motors, Switched Reluctance Motors	2
15.	EV Machine Cut-out section	for demonstration & training	2
16.	EV mock layout	for demonstration & training	2
17.	Lithium Ion Battery	12V, 7Ah	3
18.	Lead-acid battery	12V, 7Ah	3
19.	Nickel-based batteries (metal hydride and cadmium battery).	12V, 7Ah	3
20.	Battery internal resistance meter	For O.C. voltage & internal battery resistance of each cell	3
21.	Cell Capacity tester	Up to 15V batteries and 3A load current, 10mV voltage and 1mA current resolution, Automatic detection of termination voltage, LED display with a 3-button interface.	3
22.	BMS setup	For Demonstration & training	3
23.	DC power supply	0-32V	3
24.	Power diodes	Power diodes of different current values.	1, 4
25.	Transistors	Power Transistors (NPN, PNP) for Low-frequency high-power applications.	1,4
26.	Voltage Sensors	0-12 Volts.	1,3,4

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
27.	Current Sensors	Volts: + 15v, 0-5v, Current: 4-20mA.	1,3,4
28.	Converter Models	DC to DC and DA to AC converter model	4
29.	Charging Station Simulator	For Demonstration & training purposes.	4
30.	EV Technology layout 3D poster with frame	Fuel cell, EV- Charging Systems, HEV, FCEV, Motors & Controllers etc.	3,4

R)   Suggested Learning Resources:

(a)   Suggested Books :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Handbook on Electric Vehicles Manufacturing (E-Car, Electric Bicycle, E- Scooter, E-Motorcycle, Electric Rickshaw, E- Bus, Electric Truck with Assembly Process, Machinery Equipments & Layout)	P.K. Tripathi	Niir Project Consultancy Services; 1st edition (1 January 2022) ISBN-13 : 978-8195676927
2.	Electric Vehicles: And the End of the ICE age	Anupam Singh	Kindle Edition ASIN : B07R3WFR28
3.	Wireless Power Transfer Technologies for Electric Vehicles (Key Technologies on New Energy Vehicles)	Xi Zhang, Chong Zhu, Haitao Song	Springer Verlag, Singapore; 1st ed. 2022 edition (23 January 2022) ISBN-13 : 978-9811683473
4.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	EHSANI	CRC Press; Third edition (1 January 2019)ISBN-13 : 978-0367137465
5.	Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles	John G. Hayes, G. Abas Goodarzi	Wiley; 1st edition (26 January 2018) ISBN-13 : 978-1119063643
6.	New Perspectives on Electric Vehicles	Marian Găiceanu (Editor)	IntechOpen (30 March 2022) ISBN-13 : 978-1839696145

(b)   Suggested Open Educational Resources (OER):

1. https://www.energy.gov/eere/fuelcells/fuel-cell-systems
2. https://powermin.gov.in/en/content/electric-vehicle
3. https://www.iea.org/reports/electric-vehicles
4. https://www.oercommons.org/search?f.search=Electric+Vehicles

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c)   Others: (If any)

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

S)   Course Curriculum Development Team(NITTTR)
- Dr. A. S. Walkey(Coordinator)
- Dr. S. S. Kedar(Co-coordinator)

A)	Course Code	: 2000505 H / 2000508 H / 2000511H
B)	**Course Title**	: **Robotics (Basics)**
C)	Pre- requisite Course(s)	:
D)	**Rationale**	:

Currently, industries demand non-stop and fine quality work in different processes used. It is difficult for the human beings to give same quantity and quality of work with respect to time, environment and complexity of the work in any process industry. To get quality and quantity of work in toughest environment or the environment which is not suitable for the humans to work, industries demand for robots and its operator. Operators who will operate these robots need some basic knowledge of robotics. To fulfill the need of industries and looking to the advancement in technology, this course aims for the diploma engineers to have knowledge and skills in robotics.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-
Select robots for given applications employing basic concepts of design and functions of robots.

Interpret co-ordinate systems and degree of freedom for robots.

Use sensors and drives in context of various robotic applications.

Select appropriate robot control techniques,

Use programs to operate robots.

F) **Course Articulation Matrix:**

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs) (if any)		
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**	**PSO-3**
CO-1	3	-	3	-	2	2	2			
	3	2	1	2	-	-	-			
CO-2	3	2	1	2	2	-	2			
CO-3	3	1	1	2	-	-	-			
CO-4	3	2	3	3	2	3	2			

Legend: High (3), Medium (2), Low (1) and No mapping (-)

G) **Scheme of Studies:**

	Course Code	Course Title	Scheme of Studies (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (SW+ SL)	Total Hours (CI+LI+SW+SL)	Total Credits(C)
			L	**T**				
Legend: CI:	2000505H/ 2000508H/ 2000511H	Robotics (Basics)	02	-	04	02	08	05

Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI :   Laboratory Instruction (Includes experiments/practical performances in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

SW: Sessional Work/Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, open educational resources (OERs)

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: SW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H)   Scheme of Assessment:

Course Code	Course Title	Scheme of Assessment (Marks)							Total Marks (TA+SWA+LA)
		Theory Assessment (TA)		Sessional Work Assessment (SWA)		Lab Assessment (LA)			
		Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Progressive Sessional Work Assessment (PSWA)	End Sessional Work Assessment (ESWA)	Progressive Lab Assessment(PLA)	End Laboratory Assessment (ELA)		
2000505H / 2000508H / 2000511H	Robotics (Basics)	30	70	**20**	**30**	20	30		200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

SWA: Sessional Work/Term work & Self Learning Assessment (Includes assessment related to student performance in self learning, assignments, Seminars, micro projects, industrial visits, any other student activities etc.

Note: Separate passing is must for progressive and end semester assessment for both theory and practical.

I)   Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Sessional Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Indian Knowledge System (IKS) and others must be integrated appropriately.

J)   Theory Session Outcomes (TSOs) and Units: [2000505H]

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Explain the basic terms used in robotics TSO 1b.Identify components used in robots. TSO 1c. Explain various types of movements. TSO 1d.Distinguish various robots' configurations and their workspace. TSO 1e. Evaluate the degrees of freedom of the given robot. TSO 1f. Specify the methods of conversion of the given linear motion into rotary motion and vice-versa. TSO 1g. List the criteria for selecting robot for the given simple application with justification.	**Unit-1.0 Basics of Robotics Systems** 1.1 Definition, need, brief history of robotics 1.2 Basic Robot terminology, configuration and its working 1.3 Robot components overview - Manipulator, End effecters, Drive system, Controller, Sensors 1.4 Basic structure of a Robot and Classification – Cartesian, Cylindrical, Spherical, Horizontal articulated (SCARA),Parallel; Mechanic alarm, Degree of freedom, Links and joints, Wrist rotation,Mechanical transmission-pulleys, belts, gears, harmonic drive (gear box) 1.5 Linear and Rotary motion and its devices 1.6 Selection criteria for robots	CO1,CO2

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 2a. Explain the working of various types of End effecters used in robots with diagram. TSO 2b. Explain with sketches the function of the given sensing device used in a robot. TSO 2c. Describe working of the given sensor used in robot. TSO 2d. Explain the given robot configuration. TSO 2e. Select relevant robot sensors for a given application with justification. TSO 2f. Describe robot machine vision concepts along with block diagram of robot vision system. TSO 2g. Select vision equipment for a given robotic application.	**Unit– 2.0 Robot Components** 2.1 End effecters: types, sketches, working and applications 2.2 Sensing and Feedback devices: Optical sensors, Proximity sensors, LVDT, Thermocouple, RTD, Thermistor, Force sensing – strain gauge, Piezoelectric, Acoustic sensing Feedback devices; Potentiometers; Optical encoders; DC tachometers; 2.3 Robot machine vision: Block diagram of robot vision system, Vision equipment-camera, Imaging Components: Point, Line, Planar and Volume Sensors, Image processing, Part recognition and range detection	CO3
TSO 3a. Explain with sketches the function of the specified actuator used in a robot. TSO 3b. Differentiate between open loop and closed loop systems. TSO 3c. Explain various robotic controls. TSO 3d. Describe block diagrams of the given control system. TSO 3e. Specify drive system used for robotic control as per requirement. TSO 3f. Differentiate the various robot path controls. TSO 3g. Justify the selection of actuators, drives, control system, AC servo motor and path control for making of a robot.	**Unit– 3.0 Robotic Drive System and Controller** 3.1 Actuators; Hydraulic, Pneumatic and Electrical drives; linear actuator; Rotary drives 3.2 Control systems : Open loop and close loop with applications and its elements, Servo and non-servo control systems – Types, basic principles and block diagram Robot controller; Level of Controller 3.3 AC servo motor; DC servo motors and Stepper motors; 3.4 Robot path control: Point to point, Continuous path control and Sensor based path control	CO4
TSO 4a. Explain various robot programming languages. TSO 4b. Programme robot for a given simple job. TSO 4c. Describe the procedure to simulate the given robot movements using the relevant software.	**Unit– 4.0 Introduction to Robot Programming** 4.1 Need and functions of programming 4.2 Methods of robot programming: Manual Teaching, Teach Pendant, Lead through, Programming languages. Programming with graphics. 4.3 Programming languages: Types, features and applications 4.4 Controller programming 4.5 Simulation for robot movements	CO5
TSO 5a. Select a robot for the given application. TSO 5b. Describe various applications of Robotics. TSO 5c. Explain safety norms in robot handling. TSO 5d. Describe maintenance procedure for the given robot. TSO 5e. Describe common problems in robot operations and suggest remedial action.	**Unit– 5.0 Robotics Applications and Maintenance aspects** 5.1 Application robots including special types 5.2 Robot maintenance: Need and types 5.3 Common troubles and remedies in robot operation. 5.4 General safety norms, aspects and precautions in robot handling	CO1,CO2, CO3,CO4

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)

Note: One major TSO may require more than one Theory session/Period.

K) Laboratory (Practical) Session Outcomes (LSOs) and List of Practical [2000508H]

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 Identify parts of Robot on the basis of function. 1.2 Identify joint type & link parameters (link length, link twist, and Link offset), rotational vs. linear motion, used in robot.	1.	Identify components and different configurations of robots.	CO1
LSOs 2.1 Identify different types of robot end effecters. 2.2 Use Mechanical grippers to hold objects. 2.3 Use Vacuum grippers to hold objects.	2.	Pick/hold different objects (shape/weight/stiffness) using robot end effecters.	CO1, CO2
LSOs 3.1 Assemble the complete robot using the components as per the procedure 3.2 Apply the functionalities available in rotor trainer kit. 3.3 Test for various configurations. 3.4 Test for various degrees of freedom.	3.	Assemble robot to test various configurations and degrees of freedom using robot trainer kit.	CO1, CO2
LSOs 4.1 Identify various types of sensors used in robotic application. 4.2 Measure angular motion using Synchros. 4.3 Detect objects using optical sensors.	4.	Use different types of robotic sensors for a specific situation.	CO3
LSOs 5.1 Interface stepper motor. 5.2 Control robot with stepper motor interfacing.	5.	Perform robot control with stepper motor interfacing	CO3
LSOs 6.1 Draw the labelled sketch of individual parts and robot arm. 6.2 Assemble the arm using the parts as per the procedure. 6.3 Interface the motor drive and operate.	6.	Assemble robot arms using mechanical transmission components and interface motor drive.	CO2, CO3
LSOs 7.1 Use open source or available relevant software to develop pick and place programme. 7.2 Perform simulation.	7.	Perform pick and place operation using Simulation Control Software.	CO5
LSOs 8.1 Develop programme for using a robot arm with three degrees of freedom. 8.2 Execute the programme.	8.	Perform 2D simulation of a 3 DOF robot arm.	CO2, CO4, CO5

Practical/Lab Session Outcomes(LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 9.1 Apply stepper motor control with direction control and step control logic simulation. 9.2 Perform basic PLC programming 9.3 Develop ladder logic programs 9.4 Use programming timers	9.	Programme 5-axis Robotic arm to control various motions.	CO3, CO4, CO5
LSOs 10.1 Develop a program for a simple application. 10.2 Execute the robot programme.	10.	Program to execute a simple robot application (like painting, straight welding) using a given configuration.	CO4, CO5

L) **Sessional Work and Self Learning: [2000511H]**

    a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

    b. **Micro Projects:** A suggestive list of micro-projects is given here. Similar micro-projects that match the COs could be added by the concerned course teacher. The student should strive to identify eco-friendly or recycled material prior to selection for robotic applications.
1. Develop stair climb robot using robotic components.
2. Develop RF controller robot using robotic components.
3. Develop robot for metal detection application using robotic components.
4. Develop line follower robot using robotic components.
5. Develop solar floor cleaner robot using robotic components.
6. Develop solar tracker system using robotic components.
7. Develop a greenhouse managing robot for a horticulture application.

    c. **Other Activities:**
1. Seminar Topics: Recent developments in the field of robotics
2. Visits: Visit an automation industry and prepare report for various types of robots employed there and details of any one type of special purpose robot used
3. Case Study: Identify a robotic application in automobiles and present a case study
4. Self learning topics:
   - History of industrial robot
   - Sociological consequences of Robots

M) **Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Sessional Work Assessment (SWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Sessional Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	20%	20%	10%	25%	10%	20%
CO-2	20 %	25%	20%	10%	25%	20%	20%
CO-3	25%	25%	20%	25%	25%	20%	20%
CO-4	20%	20%	20%	15%	25%	20%	20%
CO-5	15%	10%	20%	40%	--	30%	20%
Total	30	70	20	20	10	20	30

Marks			50		

Legend:
* : Other Activities include self learning, seminar, visits, surveys, product development, software development etc.
** : Mentioned under point- (N)
# : Mentioned under point-(O)
Note: For CO attainment calculation, Indirect assessment tools like Course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Specification Table for End Semester Theory Assessment:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and sessional work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

Unit Number and Title	Relevant COs Number(s)	Total Marks	ETA (Marks)		
			Remember (R)	Understanding (U)	Application & above (A)
Unit-1.0 Basics of Robotics Systems	CO1,CO2	20	7	7	5
Unit– 2.0 Robot Components	CO2,CO3	16	3	8	5
Unit– 3.0 Robotic Drive System and Controller	CO3,CO4	12	4	4	5
Unit– 4.0 Introduction to Robot Programming	CO5	10	2	4	4
Unit– 5.0 Robotics Applications and Maintenance aspects	CO1,CO2, CO3,CO4	12	4	4	4
	Total Marks	70	20	27	23

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Specification Table for Laboratory (Practical) Assessment:

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA (%)	PDA (%)	
1.	Identify components and different configurations of robots.	CO1	30	50	20
2.	Pick/hold different objects (shape/weight/stiffness) using robot end effecters.	CO1, CO2	60	30	10
3.	Assemble robot to test various configurations and degrees of freedom using robot trainer kit.	CO1, CO2	70	20	10
4.	Use different types of robotic sensors for a specific situation.	CO3	60	30	10
5.	Perform robot control with stepper motor interfacing	CO3	70	20	10
6.	Assemble robot arms using mechanical transmission components and interface motor drive.	CO2, CO3	60	30	10
7.	Perform pick and place operation using Simulation Control Software.	CO5	70	20	10
8.	Perform 2D simulation of a 3 DOF robot arm.	CO2, CO4, CO5	60	30	10
9.	Programme 5-axis Robotic arm to control various motions.	CO3, CO4, CO5	60	30	10
10.	Program to execute a simple robot application (like painting, straight welding) using a given configuration.	CO4, CO5	60	30	10

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology

(ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S.No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
1.	Programmable Robot trainer kit	Trainer kit with - Minimum 3 linkages, Minimum 4 degree of freedom, Mechanical end effecter with servo control, interfacing card (RC servo output, sensors input)	1,2,3
2.	Robotic Arm Control Trainer Kit	botic Arm with five axis control application through PLC.; PLC; Digital Inputs: 8 Nos with 4mm banana sockets for getting the external inputs; Digital Outputs: 6 Nos with 4mm banana sockets for applying the inputs; Digital Input Controls: On board Toggle switches, Push Buttons & input potentiometers; Digital Outputs Controls: 6 nos. on board LED indicators; PC interfacing facility through RS-232.	8,9
3.	Proximity trainer kit	Indicator Type:LED; PCB Type Glass Epoxy SMOBC PCB; Interconnections: 2mm banana Patch cords; On board DC motor to see the application of Proximity sensor. Test points to analyse the signal On board variable supply to vary the speed of DC motor. ON/OFF switch and LED for power indication. All interconnections to be made using 2mm banana Patch cords. User manual and patch cords. Built-in power supply. Robust enclosure wooden/plastic box.	4
4.	Robot - Line Tracking Mouse Kit	Product Dimensions (20.3 x 11.4 x 8.9 cm); programmed IC, 2 unassembled gear motors, printed circuit boards, mouse-shaped plastic body, necessary components and wires, step-down power converter	3, 4,5
5.	Intelligent Robot Actuator Module	Integrity Serial Bus System, CAN to Build Intelligent Device Network, Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor, movable Omni Wheel of Omni-Directional, Actuator operation control by DC Encoder Motor, DC-Motor control and operation by Accelerometer, Gyro, Ultrasonic and PSD sensor, Androx Studio; brushless ILM 70×10 Robo Drive DC motor; sensor-actuator units of ARMAR-4; SD-25-160-2A-GR-BB Harmonic Drive reduction gear unit high gear ratio of 160: 1; structural parts (white) are made out of high-strength aluminium, Hollow shaft with strain gauges for torque sensing, motor's magnetic incremental encoder (AMS5306), digital buses (SPI or 12C); Motor interface PCB includes a 13-Bit temperature-to-digital converter with a temperature range from −40°C to 125°C (Analog Devices ADT7302)	3, 4, 5
6.	6-axis Robotics Trainer	Programmable robotic arm with an interactive front panel. Software to demonstrates functioning of the trainer as well as allows a user	3, 4, 5

S.No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/ Practical Number
		to develop their own programs. NV330; 8 bit microcontroller to ARM processors; Record and Play capability; Optional interfacing with PLC; Touch operated ON/OFF switch; Auto set to home position; Applications can be developed; Data acquisition using USB	
7.	Robotic Drive System	AC servo motor; DC servo motors, Stepper motors; DC tachometers, etc.	1,3,5,6,7,10
8.	Robot simulator for Robotics	Educational networking licensed Robotic system with simulation software	8, 10
9.	Assorted sensors	Optical encoders, Acoustic sensors ,IR, Potentiometer, RTD, Thermistor, strain gauge, piezoelectric, etc	4
10.	Vision equipment	Camera, Imaging Components: Point, Line, Planar and Volume Sensors	1, 4,10

R)   Suggested Learning Resources:

(a)   Suggested Books :

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Robotics Mechanics and Control	John Craig	Pearson Education ; 978-9356062191
2.	Industrial Robotics -Technology, Programming and Applications	Nicholas Odrey Mitchell Weiss, Mikell Groover Roger Nagel, Ashish Dutta	McGraw Hill Education; 2nd Edition; 978 -1259006210
3.	Robotic engineering : an integrated approach	Richard D. Klafter, Thomas A. Thomas A. Chmielewski, Michael Negin	Prentice Hall of India, N.Delhi , 978-8120308428
4.	Industrial Robotics Technology, Programming and Applications	Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey	McGraw-Hill Education , Second Edition, 978-1259006210
5.	Robotics	Appuu Kuttan K. K.	Dreamtech Press, First Edition, 2020, 978-9389583281
6.	Introduction to Robotics: Analysis, Control, Applications	Saeed B.Niku	Wiley; Second Edition, 978-8126533121
7.	Essentials of Robotics Process Automation	S. Muhkerjee	Khanna Publication, First edition, 978-9386173751
8.	Robotics	R R Ghorpade , M M Bhoomkar	Nirali Prakashan 978-9388897020

(b)   Suggested Open Educational Resources (OER):

1. https://archive.nptel.ac.in/courses/112/105/112105249/
2. https://openlearning.mit.edu/mit-faculty/residential-digital-innovations/task-centered-learning-intro-eecs-robotics
3. http://www.mtabindia.com/
4. http://www.robotics.org/
5. https://en.wikipedia.org/wiki/Industrial_robot
6. http://www.servodatabase.com

7. https://www.youtube.com/watch?v=fH4VwTgfyrQ
8. https://www.youtube.com/watch?v=aW_BM_S0z4k
9. https://uk.rs-online.com/web/generalDisplay.html?id=ideas-and-advice/robotic-parts-guide
10. https://www.automate.org/industry-insights/smarter-robot-grasping-with-sensors-software-the-cloud
11. https://www.iqsdirectory.com/articles/machine-vision-system.html

Note: Teachers are requested to check the creative commons licence status/ financial implications of the suggested OER, before use by the students.

(c)   Others: (If any)

1. Learning Packages
   - https://www.edx.org/learn/robotics
   - https://www.coursera.org/courses?query=robotics
   - https://www.udemy.com/topic/robotics/
   - https://library.e.abb.com/public/9a0dacfdec8aa03dc12578ca003bfd2a/Learn%20with%20ABB.%20Robotic%20package%20for%20education.pdf

2. Users' Guide
   - https://roboindia.com/store/DIY-do-it-your-self-educational-kits-robotics-embedded-system-electronics
   - https://www.robomart.com/diy-robotic-kits
   - https://www.scientechworld.com/robotics

3. Lab Manuals
   - http://www-cvr.ai.uiuc.edu/Teaching/ece470/docs/ROS_LabManual.pdf
   - https://www.jnec.org/labmanuals/mech/be/sem1/Final%20Year%20B.Tech-ROBOTICS%20LAB%20%20MANUAL.pdf

ESTIMATING AND COSTING LAB

Subject Code		Practical					Credits
2015506	No.	of Periods Per Week		Full Marks	:	50	02
	L	T	P/S	Internal (PA)	:	15	
	—	—	04	External (ESE)	:	35	

Course Objectives:
 Following are the objectives of this course:
 • To learn the procedure for estimating and costing of Civil Engineering works.
.   • To perform rate analysis for different items associated with construction projects.

CONTENTS : PRACTICAL

LIST OF PRACTICALS - (ANY Eight):-

1	Prepare the list of items to be executed with units for detailed estimate of a given structure from the given drawing.
2.	Prepare a report on market rates for given material, labour wages, hire charges of tools & equipment's required to construct the given structure as mentioned in at Serial number 1 above.
3.	Recording in Measurement Book (MB) for any four items.
4.	Prepare bill of quantities of given item from actual measurements. (Any four items).
5.	Prepare approximate estimate for the given civil engineering works.
6.	Calculate the quantity of items of work from the given set of drawings using standard measurement sheet for load bearing residential structure (1BHK Building with staircase).
7.	Prepare detailed estimate from the given set of drawings using "standard measurement and abstract format" for RCC framed structure (G+1 Building).
8.	Calculate the reinforcement quantities from the given set of drawings for a room size of 3 m X 4 m with bar bending schedule (footing, column, beam, lintel with chajja, slab).
9.	Prepare rate analysis for the given five items of works.
10	Prepare detailed estimate of road of one kilometre length from the given drawing.
11	Prepare detailed estimate of small Septic tank from the given set of drawings.

Text/ Reference Books: -		
Titles of the Book	Name of Authors	Name of the Publisher
Estimating and costing, specification and valuation in civil engineering	M Chakraborti	Monojit Chakraborti, Kolkata
Estimating and Costing	S.C Rangwala	Charotar Publishing House, Anand.
Estimating and Costing	G.S Birdie	Dhanpat Rai Publishing Company (P) Ltd. Delhi.
Estimating and Costing in Civil engineering	B.N. Datta	UBS Publishers Distributors

Course outcomes:

After completing this course, student will be able to:

CO 1 : Select modes of measurements for different items of works.

CO 2 : Prepare approximate estimate of civil engineering works.

CO 3 : Prepare detailed estimate of civil engineering works.

CO 4 : Justify rate for given items of work using rate analysis techniques.

DESIGN OF STEEL AND RCC STRUCTURES LAB

Subject Code	Practical						Credits
2015508A	**No. of Periods Per Week**			**Full Marks**	**:**	**50**	**02**
	L	**T**	**P/S**	**Internal (PA)**	**:**	**20**	
	—	**—**	**04**	**External (ESE)**	**:**	**30**	

Course Objectives:

Following are the objectives of this course:

• To learn the concept of limit state design of tension and compression steel members.

• To understand design of steel beams.

• To learn the concept of limit state design of RCC beams.

CONTENTS: PRACTICAL

List of Practical's to be performed: (Any eight)

1	Draw any five commonly used rolled steel sections and five built up sections.
2	Summarize the provisions of IS 800 required for the design of tension member in report form.
3	Compile relevant clauses from IS 800 required for the design of a compression member and submit it in report form.
4	Draw sketches for single & double lacing of given built up columns.
5	Draw sketches for battening of given built up columns.
6	Prepare a report on the IS 800 provisions pertaining to design of lacing & battening along with its significance.
7	Draw cross section, strain diagram & stress diagram for singly reinforced section.
8	Draw cross section, strain diagram & stress diagram for doubly reinforced section.
9	Design simply supported I section steel beam for udl.
10	Design beam section for shear as per IS 800 provisions.
11	Draw sketches of different types of column footings.
12	Interpret the actual RCC Structural Drawings used on site with reference to reinforcement details of various structural elements.
13	Prepare a checklist for reinforcement provided from actual drawings used on site for various structural elements.
14	Prepare a detailed report of site visit for reinforcement detailing of structural elements like beams, columns, staircase & footing.
15	Prepare a detailed report of site visit for study of rolled steel tension & compression members used in various structures.

Text/ Reference Books: -		
Titles of the Book	Name of Authors	Name of the Publisher
Design of Steel Structures	P. Dayarathnam	S. Chand and Company, Delhi.
Reinforced Concrete Design Principles and Practice	Krishna Raju and N.Pranesh R. N.	New Age International, Mumbai.
Reinforced concrete Design	S.U Pillai, and Devdas Menon,	McGraw Hill Publications, New Delhi.
Limit State Design of Reinforced Concrete	P. C Varghese	Prentice Hall India Learning Private Limited, Delhi.
Design of Steel Structures	N Subramanian	Oxford University Press.

Course outcomes:

After completing this course, student will be able to perform:

CO 1 : Design of steel tension and compression member.

CO 2 : Design of steel beams including check for shear.

CO 3 : Prepare checklist for reinforcement required at the site.

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IN-PLANT TRAINING (TW)

Subject Code 2015509	Term Work						Credits
	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal (PA)	:	15	.
	—	—	Four Weeks	External (ESE)	:	35	.

Course objectives:

Following are the objectives of this course:

- To get the hands-on experience of civil engineering works.

- To gain relevant knowledge and skills.

- To provide industry exposure to students.

- To Learn about team work, communication skills and responsibilities.

CONTENTS: TERM WORK:

Getting Your Feet Wet

Internships / In plant Training are a proven way to gain relevant knowledge, skills, and experience while establishing important connections in the field. Internships are also a way to get your feet wet and find out if a specific field is something you could see yourself doing full-time in the field of civil engineering.

What Employers Want

Internships and In Plant Training make candidates more competitive in the job market. In addition to gaining exposure and experience in the field of civil engineering, they also provide an opportunity to see if the particular career field is the right one based on getting personal experience in the field. No matter what opportunities you engage in, it's important to maintain professionalism and take on the individual responsibility that is required.

Course outcomes:

After completing this course, student will be able to:

CO 1 : Get the hands-on experience of civil engineering works.

CO 2 : Gain relevant knowledge and skills.

CO 3 : Get industry exposure

CO 4 : Learn about team work, communication skills and responsibilities.

*****

MINOR PROJECT

Subject Code	Term Work						Credits
2015510	**No. of Periods Per Week**			**Full Marks**	**:**	**25**	**02**
	L	**T**	**P/S**	**Internal (PA)**	**:**	**07**	.
	—	—	**04**	**External (ESE)**	**:**	**18**	.

Course objectives:

For minor projects, a group of 2 to 6 students work under a guide or a staff to get a certain result. The course objective of this course are as follows: -

- To understand the learnings of civil engineering domain better
- To enable the students to do hands-on practical works and to gain practical experience
- To provide the chance to showcase the skills obtained
- To Learn about team work, communication skills and responsibilities.

CONTENTS: TERM WORK

The students can do any kind of projects based on their area of interests or subjects from civil engineering domain. The project can be selected from any civil engineering system like Building construction system, transportation engineering system, irrigation engineering system. A topic for project can also be selected on recent development in civil engineering.

Following are the list /areas of suggested civil engineering projects to be undertaken by a group of 2 to 6 students:

1. Prepare detailed estimate for the construction of slab culvert.

2. Prepare a report of cropping pattern for the given irrigation project in your area with reference to growth in yield, increase in CCA & GCA.

3. Prepare a report of visit to any one prefabricated unit.

4. Collect data of Prestressed components manufactured in your vicinity.

5. Prepare a model of traffic controlling devices.

6. Perform traffic survey of busy road junction of your area.

7. Collect the information of various types of steel connections used in actual practice.

8. Enlist various software's used for the design of R.C.C. and steel structure and give details of any one software.

Any other similar project can be selected. The project report has to be submitted by the students in a standard format:

Course outcomes:

After completing this course, student will be able to:

CO 1 : Decide and collect data for projects.

CO 2 : Read and interpret the drawing data.

CO 3 : Design the components.

CO 4 : Apply the principles, rules, regulations and byelaws.

CO 5 : Plan for different phases of a task.

CO 6 : Prepare drawings for project.

TERM WORK
Course Under Moocs / NPTEL / Others

Subject Code 2015511	Term Work			No of Period in one session:30			Credits
	No. of Periods Per Week			Full Marks	:	50	
	L	T	P/S	Internal (PA)	:	20	01
	-	-	02	External (ESE)	:	30	

COURSE PRIMAVERA/ 3D MAX / OTHERS

Subject Code 2015512	Term Work			No of Period in one session:			Credits
	No. of Periods Per Week			Full Marks	:	25	
	L	T	P/S	Internal (PA)	:	07	01
	—	—	02	External (ESE)	:	18	

Course objectives:

- This course provides hands-on training for Primavera's client/server-based solution, leading participants through the entire project life cycle, from planning to execution. Topics include adding activities, assigning resources, and creating a baseline. Participants also gain a thorough background in the concepts of planning and scheduling. All workshops and instruction stress the three basic elements of project management: schedule, resource and costs. Professional Development and Continuing Education

- Learn to ¬ Create a project ¬ Add activities ¬ Schedule a project ¬ Assign resources ¬ Adjust project schedule ¬ Create reports

<u>Course Topics</u>:

1. **Data, Navigating, and Layouts**¬ Describe enterprise and project-specific data. ¬ Log in ¬ Open an existing project ¬ Navigate in the Home window and Activities window ¬ Open an existing layout ¬ Customize a layout ¬ Save a layout

2. **Enterprise Project Structure** ¬ Describe the components that comprise the Enterprise Project Structure ¬ View the EPS

3. **Creating a Project-**Create a project

4. **Creating a Work Breakdown Structure** ¬ Define a Work Breakdown Structure ¬ Create multiple levels of a WBS hierarchy

5. **Adding Activities** ¬ Describe an activity and its components ¬ Describe activity types ¬ Add activities ¬ Add a Notebook topic to an activity ¬ Add steps to an activity ¬ Assign activity codes to activities

6. **Creating Relationships** ¬ View a network logic diagram ¬ Differentiate between the four relationship types ¬ Create relationships in the Activity Network ¬ Create relationships in Activity Details

7. **Scheduling** ¬ Perform a forward and backward pass ¬ Describe float and its impact on a schedule ¬ Identify loops and open ends ¬ Calculate a schedule ¬ Analyze the scheduling log report

8. **Assigning Constraints** ¬ Apply an overall deadline to a project ¬ Apply a constraint to an individual activity ¬ Add notebook topics to constrained activities ¬ Describe the available constraint types

9. **Maintaining the Project Documents Library** ¬ Describe the difference between a work product and a reference document ¬ Create a document record ¬ Link the document record to a project document or work product ¬ Assign the project document to an activity or WBS

10. **Formatting Schedule Data** ¬ Group activities according to a specific criteria ¬ Sort activities

11. **Roles and Resources** ¬ Describe roles ¬ Views the roles dictionary ¬ Describe resources ¬ Identify the differences between labor, nonlabor and material resources ¬ View the resource dictionary

12. **Assigning Roles** ¬ Assign roles to an activity ¬ Assign rates on roles

13. **Assigning Resources and Costs** ¬ Assign resources by role ¬ Assign labor, nonlabor, and material resources to activities ¬ Adjust Budgeted Units/Time for a resource ¬ Assign expenses to activities

14. **Analyzing Resources** ¬ Display the Resource Usage Profile ¬ Format a profile ¬ Format the timescale

15. **Optimizing the Project Plan** ¬ Analyze schedule dates ¬ Shorten a project schedule ¬ Analyze resource availability

¬ Remove resource overallocation ¬ Analyze project costs

16. **Baselining the Project Plan** ¬ Create a baseline plan ¬ Display baseline bars on the Gantt Chart ¬ Modify the bars on the Gantt Chart

17. **Project Execution and Control** ¬ Describe several methods for updating the project schedule ¬ Use Progress Spotlight ¬ Status activities ¬ Reschedule the project

18. **Reporting Performance** ¬ Describe reporting methods ¬ Run a schedule report ¬ Create a resource report with the Report wizard ¬ Create a time distributed report ¬ Create a report using the current layout

19. **Project Web Site** ¬ Create and launch a project Web site ¬ Customize the appearance of a project Web site ¬ Publish activity layouts as HTML pages

STATE BOARD OF TECHNICAL EDUCATION, BIHAR
Scheme of Teaching and Examinations for
VIth SEMESTER DIPLOMA IN CIVIL ENGINEERING/ CIVIL (RURAL) ENGINEERING.
(Effective from Session 2020-21 Batch)
THEORY

Sr. No.	SUBJECT	SUBJECT CODE	Periods per Week	Hours of Exam.	Teacher's Assessment (TA) Marks (A)	Class Test (CT) Marks (B)	End Semester Exam. (ESE) Marks (C)	Total Marks (A+B+C)	Pass Marks ESE	Pass Marks in the Subject	Credits
			TEACHING SCHEME		EXAMINATION-SCHEME						
1.	Entrepreneurship and Start –ups	2000601	3	3	10	20	70	100	28	40	3
2.	Public Health Engineering	2015602	3	3	10	20	70	100	28	40	3
3.	Advanced Design of Structures	2015603	3	3	10	20	70	100	28	40	3
4.	Program Elective -III	2015604	3	3	10	20	70	100	28	40	3
	Tendering and Accounts (2015604A)				Disaster Management (2015604B)						
5.	Open Elective / COE		3	3	10	20	70	100	28	40	2
	Indian Constitution (2000605A)				Project Management (2015605B)						
	Artificial Intelligence (**Advance**) (2000605B)		Internet of Things (**Advance**) (2000605C)		Drone Technology (**Advance**) (2000605D)			3D Printing & Design (**Advance**) (2000605E)			
	Industrial Automation (**Advance**) (2000605F)				Electric Vehicles (**Advance**) (2000605G)		Robotics (**Advance**) (2000605H)				
	Total: -		15				**350**	500			14

PRACTICAL

Sr. No.	SUBJECT	SUBJECT CODE	Periods per Week	Hours of Exam.	Internal (PA)	External (ESE)	Total Marks	Pass Marks in the Subject	Credits
			TEACHING SCHEME		Practical				
6.	Elective Lab / COE Lab		4 50% Physical 50% Virtual	3	20	30	50	20	2
	Public Health Engineering Lab (2015608A)				Artificial Intelligence (**Advance**) Lab (2000608B)			Internet of Things (**Advance**) Lab (2000608C)	
	Drone Technology (**Advance**) Lab (2000608D)				3D Printing & Design (**Advance**) Lab (2000608E)			Industrial Automation (**Advance**) Lab (2000608F)	
	Electric Vehicles (**Advance**) Lab (2000608G)				Robotics (**Advance**) (2000608H)				
	Total: -		04				50		02

TERM WORK

Sr. No.	SUBJECT	SUBJECT CODE	Periods per Week	Marks of Internal (PA)	Marks of External (ESE)	Total Marks (PA+ESE)	Pass Marks in the Subject	Credits
			TEACHING SCHEME	EXAMINATION-SCHEME				
7.	Seminar	2015609	4	15	35	50	**20**	2
8.	Major Project	2015610	6	15	35	50	**20**	3
9.	Term Work		2	20	30	50	**20**	1
	Course Under Moocs /NPTEL/ Others TW (2015611)	Artificial Intelligence (Advance) TW (2000611B)	Internet of Things (Advance) TW (2000611C)		Drone Technology (Advance) TW (2000611D)			
	3D Printing & Design (Advance) TW (2000611E)	Industrial Automation TW (Advance) (2000611F)	Electric Vehicles (Advance) TW (2000611G)		Robotics (Advance) TW (2000611H)			
10.	Program Elective (TW)	2015612	4	15	35	50	**10**	2
	Tendering and Accounts (TW)- (2015612A)			Advanced Design of Structures (TW)-(2015612B)				
	Total: -		16			200		08
Total Periods per week (Each of duration One Hour) =35				Total Marks = **750**				24

ENTREPRENEURSHIP AND START –UPS

Subject Code 2000601	Theory			No of Period in one session : 42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

Course Objectives:

The main aims of the course are to familiarize students with various concepts used in understanding processes involved in entrepreneurship and business formation and development.

- To acquire Entrepreneurial spirit and resourcefulness.

- To familiarize with various uses of human resource for earning dignified means of living.

- To understand the concept and process of entrepreneurship - its contribution and role in the growth and development of individual and the nation.

- To acquire entrepreneurial quality, competency, and motivation.

- To learn the process and skills of creation and management of entrepreneurial venture.

CONTENTS: THEORY

Unit	Name of Topics	Hrs.
Unit-I	Introduction to Entrepreneurship and Start – Ups • Definitions, Traits of an entrepreneur, Entrepreneurship, Motivation • Types of Business Structures, Similarities and differences between entrepreneurs and managers.	06
Unit-II	Business Ideas and their implementation • Discovering ideas and visualizing the business • Activity map • Business Plan	06
Unit-III	Idea to Start-up • Market Analysis – Identifying the target market, • Competition evaluation and Strategy Development, • Marketing and accounting, • Risk analysis	10
Unit-IV	Management • Company's Organization Structure, • Recruitment and management of talent. • Financial organization and management	08
Unit-V	Financing and Protection of Ideas • Financing methods available for start-ups in India • Communication of Ideas to potential investors – Investor Pitch • Patenting and Licenses	08
Unit-VI	Exit strategies for entrepreneurs, bankruptcy, and succession and harvesting strategy.	04
	Total	42 hrs.

References:

1. The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company, Steve Blank and Bob Dorf, K & S Ranch ISBN – 978-0984999392
2. The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Penguin UK ISBN – 978-0670921607
3. Demand: Creating What People Love Before They Know They Want It Adrian J. Slywotsky with Karl Weber, Headline Book Publishing ISBN – 978- 0755388974
4. The Innovator's Dilemma: The Revolutionary Book That Will Change the Way You Do Business, Clayton M. Christensen, Harvard business ISBN: 978-142219602
5. Entrepreneurship and Start-ups, Ekta Sharma, FPH

SUGGESTED SOFTWARE/LEARNING WEBSITES:
   a. https://www.fundable.com/learn/resources/guides/startup
   b. https://corporatefinanceinstitute.com/resources/knowledge/finance/corporatestructure/
   c. https://www.finder.com/small-business-finance-tips
   d. https://www.profitbooks.net/funding-options-to-raise-startup-capital-for-your-business/

Course outcomes:
   Upon completion of the course, the student will be able to :

CO : 1 Understand the dynamic role of entrepreneurship and small businesses

CO :2 Organize and Manage a Small Business

CO : 3 Plan the Financial strategy and Control

CO : 4 Operate forms of Ownership for Small Business

CO : 5 Make Strategic Marketing Planning

CO : 6 Launch new Product or Service Development

CO : 7 Conceive business Plan

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PUBLIC HEALTH ENGINEERING

Subject Code 2015602	Theory			No of Period in one session : 42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

Course Objectives:

Following are the objectives of this course:
- To learn the principles for identification of sources of surface and subsurface water.
- To calculate population and requirement of drinking water.
- To understand the plotting of water supply scheme highlighting different features.
- To know evaluation of characteristics and treatment of sewage.

CONTENTS: THEORY

Unit	Name of Topics	Hrs.
Unit-I	**Sources, Demand and Quality of water:** • Sources of water: Surface and Subsurface sources of water, Intake Structures. • Demand of water: Factors affecting rate of demand, Variations of water demands, Forecasting of population, Methods of forecasting of population, (Simple problems on forecasting of population), Design period, Estimating of quantity of water supply required for city or town. • Quality of water: Characteristics of water- Physical, Chemical and Biological, Testing of water for Total solids, hardness, chlorides, dissolved Oxygen, pH, Fluoride, Nitrogen and its compounds, Bacteriological tests, E coli, B coli index, MPN, Sampling of water, Water quality standards as per IS 10500.	**08**
Unit-II	**Purification of water:** • Purification of Water: Objectives of water treatment, Aeration- objects and methods of aeration. • Plain sedimentation, Sedimentation with coagulation, principles of coagulation, types of coagulants, Jar Test, process of coagulation, types of sedimentation tanks, Clariflocculator. • Filtration -Classification of filters: slow sand filter, rapid sand filter, pressure filter. • Disinfection: Objects, methods of disinfection, Chlorination- Application of chlorine, forms of chlorination, types of chlorination practices, residual chlorine and its importance, Flow diagram of water treatment plants.	**10**
Unit-III	**Conveyance and Distribution of Water:** • Conveyance: Types of Pipes used for conveyance of water, choice of pipe material, Types of joints & Types of valves. • Distribution of water: Methods of distribution of water- Gravity, pumping, and combined system, Service reservoirs - functions and types. • Layouts of distribution of Water-Dead end system, grid iron system, circular system, radial system; their suitability, advantages and disadvantages.	**08**

Unit-IV	**Domestic Sewage and System of Sewerages:**		
	• Building Sanitation: Necessity of sanitation, Necessity to treat domestic sewage, Definitions- Sewage, sullage, types of sewage. Definition of the terms related to Building Sanitation. Water pipe, Rain water pipe, Soil pipe, Sullage pipe, Vent pipe.		
	• Building Sanitary Fittings-Water closet – Indian and European type, flushing cistern, wash basin, sinks, Urinals. Traps- types, qualities of good trap. Systems of plumbing - one pipe, two pipe, single stack.		
	• Systems of Sewerage and Sewer Appurtenances: Types of Sewers, Systems of sewerage, self-cleansing velocity and non-scouring velocity, Laying, Testing and maintenance of sewers, Manholes and Drop Manhole- component parts, location, spacing, Sewer Inlets, Street Inlets.	**10**	
Unit-V	**Characterstics and Treatment of Sewage:**		
	• Analysis of sewage: Characteristics of sewage, B.O.D., C.O.D. and its significance.		
	Objects of sewage treatment and flow diagram of conventional sewage treatment plant.		
	• Treatment of Sewage: Screening, Types of screens, Grit removal, Skimming, Sedimentation of sewage, Aerobic and anaerobic process, Sludge digestion, trickling filters		
	• Activated sludge process, Disposal of sewage, Oxidation Pond, Oxidation ditch. Septic tank, Recycling and Reuse of domestic waste.	**06**	
	Total	**42 hrs.**	

Suggested Text Book/ Reference Book:

1. Sharma S.C, Environmental Engineering, Khanna Publishing House, New Delhi
2. Garg, S.K., Environmental Engineering Vol. I and Vol. II, Khanna Publishers
3. Birdie, G. S. and Birdie, J. S.Water Supply and Sanitary Engineering, Dhanpat Rai
4. Gupta, O.P., Elements of Environmental Pollution Control, Khanna Publishing House, Delhi
5. Rao, C.S., Environmental Pollution Control Engineering, New Age International
6. Punmia, B C, Environmental Engineering, vol. I and II, Laxmi Publishers
7. Peavy H S, Rowe D R, and Tchobanoglous G, Environmental Engineering, Tata McGraw
8. Basak N N, Environmental Engineering, McGraw Hill Publishers.
9. Vikash Jain, Public Health Engineering, FPH (Foundation Publishing House)

E-REFERENCES: -

• https://nptel.ac.in/courses/105/104/105104102/
• https://nptel.ac.in/courses/105/106/105106119/

Course Outcomes:

After completing this course, student will be able to:

CO 1: Know the procedure to identify the sources of surface and subsurface water

CO 2: Estimate the quantity of drinking water required for a population

CO 3: Draw labelled layout for water supply scheme.

CO 4: Devise suitable water treatment technique.

CO 5: Evaluate the characteristics and suggest treatment of sewage.

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ADVANCED DESIGN OF STRUCTURES

Subject Code 2015603	Theory			No of Period in one session : 42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

Course Objectives:

Following are the objectives of this course:
- To understand the concepts involved in the design of riveted and welded connections.
- To know the provisions of BIS code for design of built up sections.
- To analyze T and L shaped beam sections.
- To understand the concept for design of one way and two way slabs.

CONTENTS: THEORY

Unit	Name of Topics	Hrs.
Unit-I	**Design of connections in steel structures:** • Types of rivets, Riveted connections, Strength of riveted joints, Design of riveted joints for axially loaded members. • Types of weld, welded connections, Permissible stresses in weld, Strength of weld. Advantages and disadvantages of weld, Design of fillet weld and butt weld for axial load.	**10**
Unit-II	**Steel Beams:** • Different steel sections, Simple and built up sections, Permissible bending stresses. • Design of built-up sections (symmetrical I section with cover plates only), check for shear and deflection. • Introduction to plate girder: Components and functions (no numerical).	**08**
Unit-III	**Design of RC flanged beam:** • General features of T and L beams, Advantages, Effective width as per BIS 456. • Design of singly reinforcement T beam, Stress and Strain diagram, Depth of neutral axis, Moment of resistance, T and L beams with neutral axis in flange only. • Simple numerical on location of neutral axis, Effective width of flange.	**08**
Unit-IV	**Design of slab:** • Design of simply supported one-way slab for flexure, shear and deflection and checks, as per the provisions of BIS 456. • Design of one-way cantilever slab, for Flexure including checks for Development length and Shear stress. • Design of two-way simply supported slab,	**10**
Unit-V	**Design of RCC Column and Footing design: Uni-axial bending** • IS 456 provisions, Column with uni-axial moment, Effective length calculations, Minimum eccentricity. • Design of footing for axially loaded column only.	**06**
	Total	**42 hrs.**

Suggested Text Book/ Reference Book:

1. Shah, V. L., and Gore, V., Limit State Design of Steel Structures, Structures Publications, Pune.
2. Dayarathnam, P., Design of Steel Structures, S. Chand and Company, New Delhi.
3. Subramanian N., Design of Steel Structures, Oxford University Press.
4. Sairam, K.S., Design of Steel Structures, Pearson Publication.
5. Shah, V. L., and Karve, S.R., Limit State Theory and Design of Reinforced Concrete Structures Publications, Pune.
6. Sinha N.C., and Roy S.K., Fundamentals of Reinforced Concrete, S. Chand & Co.,
7. Krishna Raju, and N.Pranesh, R.N., Reinforced Concrete Design Principles and Practice, New Age International, Mumbai.
8. Pillai, S.U., and Menon, Devdas, Reinforced concrete Design, McGraw Hill
9. Varghese, P. C., Limit State Design of Reinforced Concrete, Prentice Hall India Learning Private Limited, Delhi.
10. R.S. Desai , Advanced Design of Structures , FPH

E-REFERENCES: -

- http://www.nptelvideos.in/2012/11/design-of-steel-structures.html
- https://nptel.ac.in/courses/

Course outcomes:

After completing this course, student will be able to perform:

CO : 1 Design of riveted and welded connections.

CO : 2 Design of built up sections.

CO : 3 Design of T and L shaped beam sections.

CO : 4 Design of one way and two way slabs.

CO : 5 Design of RCC column and isolated footings.

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PROGRAM ELECTIVE –III

TENDERING AND ACCOUNTS

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Subject Code 2015604A	Theory			No of Period in one session : 42			Credits
	No. of Periods Per Week			Full Marks	:	100	03
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
				CT	:	20	

Course Objectives:

Following are the objectives of this course:
- To understand terminologies in contract and tender document and their significance.
- To know different types of contract and their uses.
- To learn preparation of typical Tender document for civil engineering work.
- To get acquainted with rent fixation and valuation of civil structures.

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CONTENTS: THEORY

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Unit	Name of Topics	Hrs.
Unit-I	**Procedure to Execute the work:** • Administrative approval, Technical sanction, budget provision, expenditure sanction. • Methods for carrying out works-contract method, departmental method – rate list method • Piece work method, day's work method, employing labours on daily wages basis.	**06**
Unit-II	**Contracts:** • Definition of contract, objects of contract, requirement of contract. • Types of engineering contract –Lump sum contract, item rate contract, percentage rate contract, cost plus percentage, cost plus fixed fee, cost plus variable percentage and cost plus variable fee contract, labour contract, negotiated contract, Annuity contract.. • Classification of contractor on basis of financial limits, Requirement of documents for registration of Contractor. • Built Operate Transfer (BOT) Project.	**10**
Unit-III	**Tender and Tender Documents:** • Definition of tender, necessity of tender, types of tender- Local, Global, Limited. • E- Tendering system – Online procedure of submission and opening of bids (Technical and Financial). • Notice to invite tender (NIT)- Points to be included while drafting tender notice, Drafting of tender notice. • Procedure of submitting filled tender Documents (Two envelope system), procedure of opening tender, • comparative statement, scrutiny of tenders, award of contract, letter of award. • Meaning of terms- Earnest Money Deposit (EMD), Performance Security Deposit, Validity period, Corrigendum to tender notice and its necessity, Unbalanced bid. • Introduction of GeM.	**09**

Unit-IV	**Accounts:** • Various account forms and their uses- Measurement Books, E-Measurement book (E-MB), • Nominal Muster Roll (NMR), Imprest Cash, Indent, Invoice, Bill, Vouchers. Hand receipt, Cash Book, Temporary Advance. Heads of Accounts. • Mode of Payment to the contractor and its necessity – Interim Payment, Advance Payment, Secured Advance, Petty Advance, Mobilization advance. • Running account bill, Final bill, Retention money, E- payment.		**07**
Unit-V	**Introduction to Valuation:** • Definition and purpose of valuation, role of valuer. Definition – Cost, Price and Value, Characteristics of Value, factors affecting value. • Types of Value – Book Value, Scrap Value, Salvage Value, Speculative Value, Distress value, Market Value, Monopoly value, Sentimental Value. Factors affecting value. • Depreciation, Obsolescence, Sinking Fund. • Methods of Calculation of Depreciation – Straight Line Method, Sinking Fund method, Constant Percentage Method. • Fixation of rent, Lease – types of lease, lease hold property and freehold property. Mortgage- Mortgage deed, precautions to be taken while making mortgage.		**10**
		Total	**42 hrs.**

Suggested Text Book/ Reference Book:

1. Datta, B. N., Estimating and Costing in Civil engineering, UBS Publishers Pvt. Ltd., New Delhi
2. Raina, V. K., Construction Management and Contract Practices, Shroff Publishers & Distributers Pvt. Ltd.
3. Rangawala, S. C., Estimating and Costing, Charotar Publishing House PVT. LTD., Gujarat
4. Birdie, G. S., Estimating and Costing, Dhanpat Rai Publishing Company(P) Ltd., New Delhi
5. Patil, B. S., Civil Engineering Contracts and Estimates, Orient Longman, Mumbai
6. Chakraborti, M., Estimating and Costing, Specification and Valuation in Civil Engineering, Monojit Chakraborti, Kolkata.
7. Tendering and Accounts :- Rahul Agarwal,FPH

E-REFERENCES: -

  • https://nptel.ac.in/courses/

Course outcomes:

After completing this course, student will be able to:

CO : 1 Suggest the relevant type of contract for the given civil engineering work.

CO : 2 Prepare the typical Tender document for the given civil engineering work.

CO : 3 Decide type of payment for the executed work.

CO : 4 Justify the rent fixation and valuation of given civil structure.

CO : 5 Initiate contract and process it.

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	Theory			No of Period in one session : 42			Credits
Subject Code 2015604B	**No. of Periods Per Week**			**Full Marks**	:	**100**	03
	L	**T**	**P/S**	**ESE**	:	**70**	
	03	—	—	**TA**	:	**10**	
				CT	:	**20**	

Course Objectives:

Following are the objectives of this course:

- To learn about various types of natural and man-made disasters.

- To know pre and post disaster management for some of the disasters.

- To know about various information and organizations in disaster management in India.

- To get exposed to technological tools and their role in disaster management.

CONTENTS: THEORY

Unit	Name of Topics	Hrs
Unit-I	**Understanding Disaster:** • Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity– Disaster and Development, and disaster management.	**06**
Unit-II	**Types, Trends, Causes, Consequences and Control of Disasters:** • Geological Disasters (earthquakes, landslides, tsunami); Hydro- Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); • Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters– Climate Change and Urban Disasters.	**10**
Unit-III	**Disaster Management Cycle and Framework:** • Disaster Management Cycle – Paradigm Shift in Disaster Management. Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and awareness. • During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation • Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure– Early Recovery – Reconstruction and Redevelopment.	**10**
Unit-IV	**Disaster Management in India:** • Disaster Profile of India – Mega Disasters of India and Lessons Learnt. Disaster Management Act 2005. • National Policy on Disaster Management, National Guidelines and Plans on Disaster Management. • Role of Government (local, state and national), Non-Government and Inter Governmental Agencies	**10**
Unit-V	**Applications of Science and Technology for Disaster Management:** • Geo-informatics in Disaster Management (GIS, GPS and RS). Disaster Communication System (Early Warning and Its Dissemination). • S&T Institutions for Disaster Management in India.	**06**
	Total	**42 hrs.**

References:

1. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

2. Bhandani, R.K., An overview on natural & manmade disasters and their reduction, CSIR, NewDelhi

3. Srivastava, H.N.,and Gupta G.D., Management of Natural Disasters in developing countries, Daya Publishers, Delhi

4. Alexander ,David ,Natural Disasters ,Kluwer Academic London

5. Ghosh ,G.K., Disaster Management ,APH Publishing Corporation

6. Murthy,D.B.N.,Disaster Management :Text & Case Studies , Deep & Deep Pvt. Ltd.

Course outcomes:

After completing this course, student will be able to:

CO : 1 Acquaint with basic information on various types of disasters

CO : 2 Know the precautions and awareness regarding various disasters

CO : 3 Decide first action to be taken under various disasters

CO : 4   Familiarize with organization in India which are dealing with disasters

CO : 5 Select IT tools to help in disaster management

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INDIAN CONSTITUTION

Subject Code 2000605A	Theory			No of Period in one session : 42			Credits
	No. of Periods Per Week			Full Marks	:	100	02
	L	T	P/S	ESE	:	70	
	03	—	—	TA	:	10	
	—	—	—	CT	:	20	

Course Learning Objectives:

Following are the objectives of this course:
- ☐ To Enable the student to understand the importance of constitution
- ☐ To understand the structure of executive, legislature and judiciary
- ☐ To understand philosophy of fundamental rights and duties
- ☐ To understand the autonomous nature of constitutional bodies like Supreme Court and high court, controller and auditor general of India and election commission of India.
- ☐ To understand the central and state relation, financial and administrative

CONTENTS: THEORY

Unit	Name of Topics	Hrs
Unit-I	**The Constitution - Introduction** • The History of the Making of the Indian Constitution • Preamble and the Basic Structure, and its interpretation • Fundamental Rights and Duties and their interpretation • State Policy Principles	08
Unit-II	**Union Government** • Structure of the Indian Union • President – Role and Power • Prime Minister and Council of Ministers • Lok Sabha and Rajya Sabha	10
Unit-III	**State Government** • Governor – Role and Power • Chief Minister and Council of Ministers • State Secretariat	08
Unit-IV	**Local Administration** • District Administration • Municipal Corporation • Zila Panchayat	08
Unit-V	**Election Commission** • Role and Functioning • Chief Election Commissioner • State Election Commission	08
	Total	42

References:

1. Ethics and Politics of the Indian Constitution Rajeev Bhargava Oxford University Press, New Delhi, 2008
2. The Constitution of India B.L. Fadia Sahitya Bhawan; New edition (2017)
3. Introduction to the Constitution of India DD Basu Lexis Nexis; Twenty-Third 2018 edition

Suggested Software/Learning Websites:

a. https://www.constitution.org/cons/india/const.html
b. http://www.legislative.gov.in/constitution-of-india
c. https://www.sci.gov.in/constitution
d. https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/

Course Outcomes:

After completing this course, student will be able to:

CO 1 : To Enable the student to understand the importance of constitution

CO 2 : To understand the structure of executive, legislature and judiciary

CO 3 : To understand philosophy of fundamental rights and duties

CO 4 : To understand the autonomous nature of constitutional bodies like Supreme Court and high court,

controller and auditor general of India and election commission of India.

CO 5 : To understand the central and state relation, financial and administrative

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Course Outcomes:

After completing this course, student will be able to:

CO 1 : To Enable the student to understand the importance of constitution

CO 2 : To understand the structure of executive, legislature and judiciary

CO 3 : To understand philosophy of fundamental rights and duties

CO 4 : To understand the autonomous nature of constitutional bodies like Supreme Court and high court,

controller and auditor general of India and election commission of India.

CO 5 : To understand the central and state relation, financial and administrative

PROJECT MANAGEMENT

Subject Code 2015605B	Theory			No of Period in one session : 42			Credits
	No. of Periods Per Week			Full Marks	:	100	
	L	T	P/S	ESE	:	70	02
	03	—	—	TA	:	10	
				CT	:	20	

Course Objectives:

Following are the objectives of this course:

- To develop an understanding of key project management skills and strategies.
- To make them understand the concepts of Project Management for planning and execution of projects.
- To make them understand the feasibility analysis in Project Management and network analysis tools for cost and time estimation.
- To enable them to comprehend the fundamentals of Contract Administration, Costing and Budgeting.
- To make them capable to analyze, apply and appreciate contemporary project management tools and methodologies in Indian context.

CONTENTS: THEORY

Unit	Name of Topics	Hrs.
Unit-I	**Concept of a project:** • Classification of projects- importance of project management- The project life cycle, establishing project priorities (scope- cost- time) project priority matrix- work break down structure.	05
Unit-II	**Capital budgeting process:** • Planning, Analysis, Selection, Financing Implementation- Review. Generation and screening of project ideas-market and demand analysis, Demand forecasting techniques. Market planning and marketing research process- Technical analysis	10
Unit-III	**Financial estimates and projections:** • Cost of projects-means of financing- estimates of sales and production, cost of production-working capital requirement and its financing- profitability projected cash flow statement and balance sheet. Break even analysis.	07
Unit-IV	**Basic techniques in capital budgeting:** • Non discounting and discounting methods- pay- back period- Accounting rate of return-net present value- Benefit cost ratio- internal rate of return. Project risk. Social cost-benefit analysis and economic rate of return. Non-financial justification of projects.	08
Unit-V	**Project administration:** • Progress payments, expenditure planning, project scheduling and network planning, use of Critical Path Method (CPM), schedule of payments and physical progress, time-cost trade off. • Concepts and uses of PERT cost as a function of time, Project Evaluation and Review Techniques, cost mechanisms. Determination of least cost duration. Post project evaluation.	12
	Total	**42 hrs.**

References:

1. Project planning, analysis, selection, implementation and review – Prasanna Chandra – Tata McGraw Hill
2. Project Management – the Managerial Process – Clifford F. Gray & Erik W. Larson - McGraw Hill
3. Project management - David I Cleland - McGraw Hill International Edition, 1999
4. Project Management – Gopala Krishnan – McMillan India Ltd.
5. Project Management-Harry-Maylor-Pearson Publication

Course outcomes:

At the end of the course, the student will be able to:

CO 1 : Understand the importance of projects and its phases.

CO 2 : Analyze projects from marketing, operational and financial perspectives.

CO 3 : Evaluate projects based on discount and non-discount methods.

CO 4 : Develop network diagrams for planning and execution of a given project.

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A)	**Course Code**		:	**2000605B/2000608B/2000611B**	
B)	**Course Title**		:	Artificial Intelligence (Advance)	
C)	**Pre- requisite Course(s)**		:	Artificial Intelligence (Basic)	
D)	**Rationale**		:		

In Artificial Intelligence (Basic) course, students have learned the basics for Artificial Intelligence problem solving techniques, data analytics and articulates the different dimensions of these areas. This Artificial Intelligence (Advance) course offers the students the comprehension of Machine learning which is a subsetof artificial intelligence in the field of computer. The course also exposes students to Tens or flow a Python-based open source library for numerical computation used in machine learning and developing neural networks. After completing the course students will be able to implement various techniques used in machine learning and neural networks using open source tools.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensurethe accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/laboratory/workshop/field/ industry.

After completion of the course, the students will be able to-

CO-1 Elaborate the use of Machine learning in Artificial Intelligence.
CO-2 Implement various supervised and unsupervised learning models and methods.
CO-3 Illustrate Artificial neural networks and its applications.
CO-4 Implement various Neural network models and Learning Methods.
CO-5 Solve machine learning and artificial neural network problems using Tens or flow.

F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes(COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainabilityand Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	-	2	2	-	-	-	1		
CO-2	3	3	3	3	-	-	2		
CO-3	-	3	3	3	-	-	2		
CO-4	3	1	3	3	-	-	2		
CO-5	3	3	3	3	-	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)
 *: PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs isoptional

G) Teaching & Learning Scheme:

Boardof Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction(CI)		Lab Instruction(LI)	NotionalHours (TW+ SL)	Total Hours (CI+LI+TW+ SL)	Total Credit (C)
			L	T				
	2000605 B/2000608B/200 0611B	Artificial intelligence (Advance)	03	-	04	02	09	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances/ problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCS, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Boardof Study	Course Code	Course Title	Assessment Scheme (Marks)							Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work &Self- Learning Assessment (TWA)		Lab Assessment(LA)			
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)		
	2000605 B/2000608B/200 0611B	Artificial Intelligence (Advance)	30	70	20	30	20	30		200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

• Separate passing is must for progressive and end semester assessment for both theory and practical.

• ETA & ELA are to be carried out at the end of the term/ semester.

• Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing:
This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the

attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units:**

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number (s)
TSO 1a. Describe the basic terminology of Machinelearning TSO 1b. Explain the concept of dataset and ways to handle them TSO 1c. illustrate the process of dataset division TSO 1d. Explain process involved in machine learning	**Unit – 1: Introduction to machine learning** Concept of Machine Learning, Define Learning, Learn the Network, Evaluate the Network, datasets and ways to handle them, Feature sets, Dataset division: test, train and validation sets, cross validation. Applications of Machine Learning, processes involved in Machine Learning	**CO-1**
TSO 2a. Identify the category or class of aparticular dataset using KNN algorithm TSO 2b. Use Linear regression for predictiveanalysis TSO 2c. Predict the categorical dependent variable using Logistic Regression TSO 2d. Use SVM for classification problems inMachine Learning TSO 2e. determine the performance of the classification models TSO 2f. evaluate the performance of the classification model using ROC-curve TSO 2g Explain characteristics of Unsupervised learning. TSO 2h. Explain different clustering methodsTSO 2i. Implement K-means clustering algorithm to group the unlabeled dataset	**Unit 2: Supervised and unsupervised learning** **Supervised learning:** Introduction to Supervised Learning, K-Nearest Neighbor, Linear Regression, LogisticRegression, Support Vector Machine (SVM), Evaluation Measures: confusion matrix, precision, precision and recall, ROC-Curve (Receiver Operating Characteristic curve) **Unsupervised learning:** Introduction to Unsupervised Learning, Introduction to clustering, Types of Clustering: Hierarchical, Agglomerative Clustering and Divisive clustering; PartitionalClustering - K-means clustering. Expectation-Maximization (EM) Algorithm	**CO-2**
TSO 3a. Explain Structure and working of BiologicalNeural Network. TSO 3b. differentiate between Artificial Neural Network and Biological Neural Network TSO 3c. State key historical points in development ofANN TSO 3d. Explain the architecture of an artificialneural network	**Unit 3: Introduction to neural networks** Structure and working of Biological Neural Network, Fundamentals of Artificial Neural Networks & Applications, Characteristics ofArtificial Neural Networks, History of neuralnetwork research, characteristics of neural networks terminology.	**CO-3**
TSO 4a. Use neuron McCulloch – Pitts model indesigning logical operations TSO 4b. Apply Rosenblatt's Perceptron to solve linear classification problems	**Unit 4: Neural networks models and LearningMethods** Models of neuron McCulloch – Pitts model,	**CO-4**

Major Theory Session Outcomes (TSOs)	Units	Relevant Cos Number (s)
TSO 4c. Implement Adaptive Linear Neuron (Adaline)training algorithm in neural network TSO 4d. Use Backpropagation neural trainingalgorithm TSO 4e. Use ART (Adaptive Resonance Theory)learning model TSO 4f: Implement Bidirectional Associative Memory (BAM) model in Artificial Neural Network	Rosenblatt's Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture, Multilayer Neural Networks, Learning Methods, Backpropagation, Counter propagation, Adaptive Resonance Theory (ART), Associative memories, BAM.	
TSO 5a. Illustrate the features of Tens or flow TSO 5b. Manipulate tensors TSO 5c. Explain features of Tens or Board visualization TSO 5d Explain the concept and features of Tens or flow playground	**Unit-5 Tensor flow** features of TensorFlow, Tensor Data structure- Rank, shape, type, one dimension and two-dimension tensor, Tensor handling and manipulations, Tensor board visualization- symbols Tensors, Variables, Automatic differentiation, Graphs and tf.function, modules layers and models, training loops, features of Tens or flow playground- data ,the ration of train and test data, features, hidden layers, Epoch, learning rate, activation function, regularization, problem type	**CO-5**

Note: One major TSO may require more than one Theory session/Period.

к) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (2000608B)

Practical/Lab SessionOutcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Implement data classification algorithms	1	Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.	**CO-2**
LSO 2.1 Implement Machine learningalgorithms LSO 2.2 Evaluate the performance of classification model	2	(a) Implement SVM for Iris Dataset- download thedataset from (https://gist.github.com/netj/8836201) (b) Find confusion matrix and evaluation matrix for SVM Hint: SVM model can be constructed using sklearn command, import pandas as pd from sklearn.svm import SVC from sklearn.model_selection import train_test_split from sklearn.metrics import confusion_matrix from sklearn.metrics import classification_report from sklearn.metrics import accuracy_score 1. Read the csv Iris dataset file 2. Condition the data 3. Condition the training and Testing data 4. Construct the Linear model 5. Test the model with Linear kernel 6. Prepare confusion matrix 7. prepare Classification Report	**CO-2**

Practical/Lab SessionOutcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 3.1 Perform clustering operations using k-means algorithm	3	a) Explore k-means algorithm for the small sample dataset. b) Explore k-means algorithm for Iris Dataset	CO-2
LSO 4.1 Perform clustering operations using EM algorithm	4	Apply EM algorithm to cluster a set of data stored in a .CSV file. Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Python ML library classes/API in the program.	CO-2
LSO 5.1 Build artificial neural networkLSO 5.2 Test artificial neural network	5	Build an Artificial Neural Network by implementing theBackpropagation algorithm and test the same using appropriate data sets.	CO-4
LSO 6.1 Detect features or business intelligence in the input data using perceptron	6	Implement the perceptron algorithm from scratch in python.	CO-4
LSO 7.1 Use Tensors for given problems	7	Write a programme to implement two dimension and three-dimension Tensor.	CO5
LSO 8.1 Use basic features for tensor handling and manipulations	8	Write a programme to add and multiply two 4x4 matrix, you can Import "tens or flow" and "numpy".	CO5
LSO 9.1 Test artificial intelligence (AI) algorithms through the use ofGoogle's TensorFlow machinelearning libraries.	9	Solve a classification problem on the Tens or flow playground. Hint: refer https://www.educba.com/tensorflow-playground/	CO5
LSO 10.1 Implement artificial intelligence(AI) algorithms through the useof Google's TensorFlow machine learning libraries LSO 10.2 perform predictive analysis using linear regression	10	Implement algorithm for linear regression in tens or flow	CO5, CO2

L) **Suggested Term Work and Self Learning (2000611B):** Some sample suggested assignments, micro project andother activities are mentioned here for reference.

   a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

   b. **Micro Projects:**
   Use python programming for the solutions of Microproject problems

   1. (a) Create a Bar plot to get the frequency of the three species of the Iris data.
      (b) Create a Pie plot to get the frequency of the three species of the Iris data.
   (c) Write a Python program to create a graph to find relationship between the sepal length and width.

   2. (a) Write a Python program to split the iris dataset into its attributes (X) and labels (y). The X variable contains the first four columns (i.e. attributes) and y contains the labels of the dataset.
   (b) Write a Python program using Scikit-learn to split the iris dataset into 70% train data and 30% test data. Out of total 150 records, the training set will contain 120 records and the test set contains 30 of those records. Print both datasets.

   3. Conduct performance analysis of Classification Algorithms (any 2) on a specific dataset.

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be assessed to calculate CO attainment.

COs	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/MidSem Test	**End Theory Assessment(ETA)**	**Term Work & Self-Learning Assessment**			**Progressive Lab Assessment (PLA)**	**End Laboratory Assessment (ELA)**
			Assignments	Micro Projects	Other Activities *		
CO-1	20%	15%	30%	20%	30%	--	--
CO-2	10%	25%	20%	20%	20%	30%	33%
CO-3	30%	25%	30%	20%	20%	--	--
CO-4	20%	20%	20%	20%	30%	30%	33%
CO-5	20%	15%	10%	20%	--	40%	34%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:
* **:** Other Activities include self-learning, seminar, visits, surveys, product development, software development etc.
** **:** Mentioned under point- (N)
# **:** Mentioned under point- (O)

Note:
- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Suggested Specification Table for End Semester Theory Assessment:** Specification table representsthe reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction(CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember(R)	**Understanding(U)**	**Application & above (A)**
Unit-1.0. Introduction to machine learning	7	**CO1**	11	5	4	2
Unit-2.0. Supervised and unsupervised learning	10	**CO2**	18	5	6	7
Unit-3.0. Introduction to neural networks	10	**CO3**	17	5	7	5
Unit-4.0.Neural networks models and Learning Methods	8	**CO4**	14	3	3	8
Unit-5.0. Tensor flow	10	**CO5**	10	2	6	2
Total Marks	**45**		**70**	**20**	**26**	**24**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Suggested Assessment Table for Laboratory (Practical):**

SN	Laboratory Practical Titles		Relevant COs Number(s)	PLA/ELA		
				Performance		Viva-Voce (%)
				PRA** (%)	PDA** (%)	
1.	Write a program to implement k-Nearest Neighbor algorithm toclassify the iris data set. Print both correct and wrong predictions. Python ML library classes can be used for this problem.		CO-2	-	80	20
2.	(a) Implement SVM for Iris Dataset- download the dataset from(https://gist.github.com/netj/8836201) (b) Find confusion matrix and evaluation matrix for SVM		CO-2	-	80	20
3.	a) Explore k-means algorithm for the small sample dataset. b) Explore k-means algorithm for Iris Dataset		CO-2	20	70	10
4.	Apply EM algorithm to cluster a set of data stored in a .CSV file.Use the same data set for clustering using k-Means algorithm. Compare the results of these two algorithms and comment on the quality of clustering. You can add Python ML library classes/API in the program.		CO-2	-	80	20
5.	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriatedata sets.		CO-4	10	70	20
6.	Implement the perceptron algorithm from scratch in python.		CO-4	10	70	20
7.	Write a programme to implement two dimension and three-dimension Tensor.		CO-5	-	80	20
8.	Write a programme to add and multiply two 4x4 matrix, you can Import "tens or flow" and "numpy".		CO-5	-	80	20
9.	Solve a classification problem on the Tens or flow playground.		CO-5	20	70	10
10.	Implement algorithm for linear regression in tens or flow		CO-2, CO-5	10	70	20

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Group Discussion, Portfolio Based Learning, Live Demonstrations in Classrooms, Lab, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment,Tools and Software	Broad Specifications	Relevant Experiment/Practic alNumber
1.	Computer Systems	Desktop Computers with i3 processor, 16 GB RAM, 512 GBHDD	S. No. 1 to 10
2.	Online Python IDE	https://www.online-python.com/	S. No. 1 to 10
3.	Jupyter Notebook	Download from https://jupyter.org/	S. No. 1 to 10
4.	Pip Python package manager	Download Pip 22.3 From https://pypi.org/project/pip/	S. No. 1 to 10
5.	Google colab	https://colab.research.google.com/github/tensorflow/docs/blo b/master/site/en/tutorials/quickstart/beginner.ipynb#scrollTo= DUNzJc4jTj6G	S. No. 1 to 10
6.	Various modules, Libraries and Packages	Tens or flow, NumPy, Pandas, package	S. No. 1 to 10

R) Suggested Learning Resources:

    (a)   Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Machine Learning using Python	Manaranjan Pradhan, U Dinesh Kumar	Wiley, ISBN-10: 8126579900 ISBN-13: 978-8126579907
2.	Introduction to Machine Learning	Jeeva Jose	Khanna Book Publishing Co. (P) ltd, 2020.ISBN-10: 9389139066 ISBN-13: 978-9389139068
3.	Machine Learning for Dummies	John Paul Mueller and Luca Massaron, For Dummies,	For Dummies; 2nd edition,ISBN-10: 1119724015 ISBN-13: 978-1119724018
4.	Machine Learning	Rajeev Chopra	Khanna Book Publishing Co., 2021ISBN-10: 9789386173423 ISBN-13: 978-9386173423
6.	Learn TensorFlow 2.0: Implement Machine Learning and Deep LearningModels with Python	Pramod Singh, Avinashmanure	Apress, 978-1484255605 ISBN-10: 1484255607 ISBN-13: 978-1484255605
7	Artificial Intelligence: Concepts, **Techniques and Applications**	Alexis Keller	States Academic Press, **2022 ISBN-**9781649649245
8	**Artificial Intelligence:** An Introduction	**Jacob** Pearson	Willford Press 2022 ISBN 9781682860911
9	**Fundamentals of** Machine Learning	Mia Williams	Willford Press 2022 ISBN 9781682860920
10	Artificial Intelligence: A Modern Approach	Emilia Stones	Larsen and Keller Education 2022 ISBN 9781641728525

(b)   Online Educational Resources:

1. NPTEL Course: Introduction to Machine Learning, Prof. Balaraman Ravindran, IIT Madras
2. https://www.tensorflow.org/resources/learn-ml
3. https://www.tutorialspoint.com/tensorflow/index.htm
4. https://www.javatpoint.com/tensorflow
5. https://developers.google.com/machine-learning/crash-course/exercises

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested OER, before use by the students.

(c)   Others:

Data Source:
- https://archive.ics.uci.edu/ml/machine-learning-databases/auto-mpg/
- https://archive.ics.uci.edu/ml/machine-learning-databases/iris/iris.data
- https://www.kaggle.com/arshid/iris-flower-dataset
- https://www.kaggle.com/rohankayan/years-of-experience-and-salary-dataset

S)   Course Curriculum Development Team (NITTTR, Bhopal)

- Dr. Sanjay Agrawal (Coordinator)
- Dr. R. K. Kapoor (Co-coordinator)

******

A)	**Course Code**	: **2000605C/2000608C/2000611C**
B)	**Course Title**	: Internet of Things (Advance)
C)	**Pre- requisite Course(s)**	: IoT (Basics), Computer Networks
D)	**Rationale**	:

The rise and rise of IoT technologies is redefining business opportunities and process. This has led to a growing need to learn advance skills to remain competitive in the market. Put together, these are a potent combination of technologies that will dictate how our future is written, which is a strong indicator of rewarding job opportunities in those domains. Introduction of the Advanced IoT follows a rigorous curriculum which blends the academic excellence and industry-relevant applications.

This course will be exposed to a breadth of skills which will help students to become multi-faceted software engineers with a deeper understanding of these modern technologies, their applications, and interdependence.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able

to-CO-1 Use basic Python features in Programming.

CO-2 Use advance Python features in Programming.

CO-3 Explain features of Cloud and IoT data storage on it.

CO-4 Explain IoT Networking and its application.

CO-5 Develop IoT App for the given problem

F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes(COs)	Programme Outcomes(POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Deve lopment of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learnin g	**PSO-1**	**PSO-2**
CO-1	3	3	2	2	-	2	-		
CO-2	3	3	2	2	-	2	-		
CO-3	1	-	3	2	2	2	2		
CO-4	1	-	2	3	-	2	2		
CO-5	3	3	3	2	2	3	3		

Legend: High (3), Medium (2), Low (1) and No mapping (-)
*   PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs isoptional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction (LI)	Notional Hours (TW+SL)	Total Hours (CI+LI+TW+SL)	Total Credits(C)
			L	T				
	2000605C/2000608C/2000611C	IoT (Advance)	03	-	04	02	09	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

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H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)							Total Marks (TA+TWA+LA)
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Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

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Note:

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- ETA & ELA are to be carried out at the end of the term/ semester.
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I) Course Curriculum Detailing:
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(LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs)

upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO.1. a. Write the steps to install Python. TSO.1. b. Explain given types of variables in python. TSO.1.c. Explain use and importance of Tuple, Dictionary, operators in python TSO.1. d. Explain use of array in python. TSO.1. e. Explain use of 2-Dimensional Array in python TSO.1. f Explain uses of given type of Conditionalstatement in python.	**Unit-1.0 Python basics: -** 1.1 Installation of Python 1.2 Variables, Print () function, Escape character sequence and run python Program 1.3 Python Tuple, Dictionary, operators 1.4 Python arrays, create, reverse and append data into it. 1.5 Python 2 Dimensional arrays. 1.6 Python Conditional statement.	**CO-1 and CO-5**
TSO.2. a. Explain uses of given type of do & whileloops in python TSO.2. b. Explain working of break, continue and pass statement in python TSO.2.c. Write the benefits of using OOPmethodology in python. TSO.2.d.Explain given type of string operation relatedto python. TSO.2.e.Explain given function in python TSO.2.f Explain use of Lambda function in python.	**Unit 2. Python Advance: -** 2.1 Python Do & while loops 2.2 Python break, continue, pass statements 2.2 Python OOPs Class, Object, Inheritance and Constructor 2.4 Python Strings Replace, Join, Split, Reverse, Uppercase, Lowercase, count, find, split and length 2.5 Python Functions, Built-in functions and user defined functions 2.6 Lambda function and uses	**CO-1 and C05**
TSO.3.a. Differentiate between Cloud and IoT cloud. TSO.3.b. Explain features of Cloud in IoT environmentTSO.3.c. List features of various types of Cloud TSO.3.d. List features of cloud services like SaaS, PaaS and IaaS TSO.3.f List advantages of cloud data storage. TSO.3.g Explain Arduino architecture and its applications. TSO.3.h Explain Raspberry pi architecture and its applications.	**Unit-3.0 Cloud features: -** 3.1 Cloud computing and IoT cloud 3.2 Benefits of cloud in IoT 3.3 Types of Cloud public, private and hybrid 3.4 Cloud services like SaaS, PaaS and IaaS 3.5 Cloud connectivity and Data storage on Cloud. 3.6 Arduino: Architecture, Programming, and Applications 3.7 Raspberry Pi Architecture, Programming, and Application basic level for IoT applications	**CO-1, CO-2 and CO-5**
TSO.4.a. Explain wired network TSO.4.b.Explain short range wireless networkTSO.4.c.Explain M2M communication TSO.4.d.Explain various generation of wireless network TSO.4.e.Explain the importance of LWPAN in IoT TSO.4.f Differentiate between SigFox & LoRaWANTSO.4.g Explain use of NB-IOT (Narrow Band IOT) TSO.4.h Create heterogenous network using RFID.	**Unit.4 IoT Networking and Application: -** 4.1 Wired and short-range wireless network 4.2 M2M – 2G, 3G, 4G & 5G networks 4.3 LPWAN – Low Power Wide Area Networks 4.4 SigFox & LoRaWAN. 4.5 NB-IOT (Narrow Band IOT) 4.6 RFID and Bar code basics- Components of an RFIDsystem-Data -Tags-Antennas- Connectors-Cables- Readers- encoder/ printers for smart labels- Controllers software 4.7 RFID advantages over Bar codes.	**CO-1 and CO-4**
TSO.5.a. Identify suitable framework for IoT app development	**Unit. 5 IoT App Development**: - 5.1 Framework selection for IoT app development	**CO-4 and**

		CO-5

Major Theory Session Outcomes (TSOs)	Units	Relevan tCOs Number(s)
TSO.5.b. Identify various stages of selected app TSO.5.c. Develop the app. TSO.5.d. Implement and deploy the app TSO.5.e Maintain and improve the app based on the feedback	5.2 Identify stages of app to be developed. 5.3 Develop, Implement, and Deploy the App 5.4 Testing and Integration 5.5 Maintain and improve	

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical (2000608C):

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 Python installation LSOs 1.2 Prepare and run python program on given problem LSOs 1.3 Prepare python program on Dictionary, Tuple and operators. LSOs 1.4 Prepare program on arrays LSOs 1.5 Prepare a program on 2-dimensional array LSOs 1.6 Create program on conditional statement	1.	1.1 Install given version of Python on the computer system. 1.2 Prepare a python program using print() function and run it. 1.3 Access given value from the tuple 1.4 Print the given value of key from the dict. 1.5 Write a Python program to create an array of 5 integers and display the array items. Access individual element through indexes 1.6 Write a Python program which takes two digits m (row) and n (column) as input and generates a two-dimensional array. 1.7 Write a python program to check whether person is eligible for voting or not. (accept age from the user) 1.8 Write a python program to check whether the entered number is even or odd. 1.9 Write a python program to check whether entered number is divisible by another entered number. 1.10 Write a python program to display "Yes" is entered number is divisible by 5 otherwise display "No"	CO-1
LSOs 2.1 Prepare python program on Do & while loopsLSOs 2.2 Prepare python program on break and continue statement. LSOs 2.3 Prepare Python program using break and continue statements LSOs 2.4 prepare python program using OOP LSOs 2.5 Prepare Python program using functions	2.	2.1 Prepare a python program which can print first 10 even and odd numbers using while statement 2.2 Write a python program which can print first 10 integers and its square using while/for loop. 2.3 Write a python program which can print sum of first 10 natural numbers using while/for loop. 2.4 Write a python program which can identify the prime number between the range given using while/for loop. 2.5 Consider a situation where you want to iterate over a string and want to print all the characters until a letter 'e' or 's' is encountered. It is specified	CO-2

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
		that you have to do this using loop and only one loop is allowed to use. 2.6 Consider the situation when you need to write a program which prints the number from 1 to 10 and but not 6. It is specified that you have to do this using loop and only one loop is allowed to use. 2.7 Create a Class with instance attributes 2.8 Create a Vehicle class without anyvariables and methods 2.9 Write a Python function to find the Max of three numbers. 2.10 Write a Python program to reverse a string.	
LSO 3.1 Signup for free cloud storage LSO 3.2 Store data into cloud and retrieve it.	3.	3.1 Create a free cloud account 3.2 Store data on cloud and retrieve it	**CO-3**
LSO 4.1 Design various types of network cablesLSO 4.2 Connect computer in LAN. LSO 4.3 Connect devices using wireless networkLSO 4.4 Connect machine with machine LSO 4.5 Connect devices using IEEE 802LSO 4.6 Connect devices using LPWAN LSO 4.7 Connect devices using RFID	4	4.1 Study of different types of Network cables and Practically implement the cross-wired cable and straight through cable using clamping tool. 4.2 Connect the computers in Local Area Network 4.3 Connect 2 or more devices using Bluetooth 4.4 Connect 2 or more devices using infrared 4.5 Connect 2 more machine using m2m 4.6 Connect 2 or more different devices using access point 4.7 Connect 2 devices using LPWAN (SmartMeter) 4.8 Connect 2 or more devices using RFID	**CO-4**
LSO 5.1 Develop a IoT app LSO 5.2 Develop IoT applications using smartphones.	5.	5.1 Identify a problem and develop an app 5.2 Building a temperature monitoring system using sensors and Smartphone	**CO-5**

L)   **Suggested Term Work and Self Learning (2000611C):** Some sample suggested assignments, micro projectand other activities are mentioned here for reference.

    a.   **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

    b.   **Micro Projects:**

      1. Prepare a report on Python programming language.
      2. Develop a small software in python to solve a IoT data analysis.
      3. Create a id on free cloud storage and share data on it for others.
      4. Create a heterogenous network and connect different dives.
      5. Create a an IoT app for the identified problem

    c.   **Other Activities:**

      1. Seminar Topics: - "Future of wireless network."

2. "Smart electricity billing ", "Cloud computing and IoT"
3. Visit to industry for IoT implementation in industrial process.
4. Reading RFID cards using 8051- RFID in the supply chain- Vehicles parking using RFID- library managementsystem- electronic toll payment- smart shipping containers fleet monitoring and management.
5. Building IoT Applications like pressure, air quality, temperature and motion detector using Arduino and raspberry-pi Universal boards.
6. Surveys of market for availability of various types of network devices and its pricing.
7. Product Development: Development of projects for real life problem solution app.
8. Software Development: Using Python

   d.   Self-learning topics:

   1. Deeper knowledge in Python features
   2. Network devices and its capabilities
   3. Advantages of IoT implementations

M)   **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities *		
CO-1	10%	10%	20%	--	33%	10%	20%
CO-2	15%	10%	20%	--	33%	15%	20%
CO-3	30%	30%	20%	--	34%	15%	20%
CO-4	20%	30%	20%	50%	--	30%	20%
CO-5	25%	20%	20%	50%	--	30%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*:   Other Activities include self-learning, seminar, visits, surveys, product development, software development etc.
**:   Mentioned under point- (N)
#:   Mentioned under point-(O)
Note:
- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Suggested Specification Table for End Semester Theory Assessment:** Specification table represents thereflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction(CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember(R)	Understanding(U)	Application& above (A)
Unit-1. Python basics	5	CO1	7	2	2	3
Unit-2. Python Advance	5	Co1, CO2	7	2	2	3
Unit-3. Cloud features	14	CO3	21	8	8	5
Unit-4. Networking and Application	14	CO4, C03	21	5	7	9
Unit-5. IoT Applications	10	CO5, CO3 andCO4	14	3	6	5
Total Marks	**48**		**70**	**20**	**25**	**25**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Suggested Assessment Table for Laboratory (Practical):**

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Install given version of Python the computer system.	CO-1	70	20	10
2.	Prepare a python program using print() function and run it.	CO-1	60	30	10
3.	Access given value from the tuple	CO-1	60	30	10
4.	Print the given value of key from the dict.	CO-1	60	30	10
5.	Write a Python program to create an array of 5 integers and display the array items. Access individual element through indexes	CO-1	60	30	10
6.	Write a Python program which takes two digits m (row) and n (column) as input and generates a two-dimensional array.	CO-1	60	30	10
7.	Write a python program to check whether person is eligible for voting or not. (accept age from the user)	CO-1	60	30	10
8.	Write a python program to check whether the entered numberis even or odd.	CO-1	60	30	10
9.	Write a python program to check whether entered number is divisible by another entered number.	CO-1	60	30	10
10.	Write a python program to display "Yes" is entered number is divisible by 5 otherwise display "No"	CO-1	60	30	10
11.	Prepare a python program which can print first 10 even and odd numbers using while statement	CO-2	60	30	10

| 12. | Write a python program which can print first 10 integers and its square using while/for loop. | CO-2 | 60 | 30 | 10 |

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA Performance PRA** (%)	PDA** (%)	Viva-Voce (%)
13.	Write a python program which can print sum of first 10 natural numbers using while/for loop.	CO-2	60	30	10
14.	Write a python program which can identify the prime number between the range given using while/for loop.	CO-2	60	30	10
15.	Consider a situation where you want to iterate over a string and want to print all the characters until a letter 'e' or 's' is encountered. It is specified that you have to do this using loop and only one loop is allowed to use.	CO-2	60	30	10
16.	Consider the situation when you need to write a program which prints the number from 1 to 10 and but not 6. It is specified that you have to do this using loop and only one loop is allowed to use.	CO-2	60	30	10
17.	Create a Class with instance attributes	CO-2	60	30	10
18.	Create a Vehicle class without any variables and methods	CO-2	60	30	10
19.	Write a Python function to find the Max of three numbers.	CO-2	60	30	10
20.	Write a Python program to reverse a string.	CO-2	60	30	10
21.	Create a free cloud account	CO-3	70	20	10
22.	Store data on cloud and retrieve it.	CO-3	60	30	10
23.	Study of different types of Network cables and Practically implement the cross-wired cable and straight through cable using clamping tool.	CO-4	70	20	10
24.	Connect the computers in Local Area Network	CO-4	70	20	10
25.	Connect 2 or more devices using Bluetooth	CO-4	70	20	10
26.	Connect 2 or more devices using infrared	CO-4	70	20	10
27.	Connect 2 more machine using m2m	CO-4	70	20	10
28.	Connect 2 or more different devices using access point	CO-4	70	20	10
29.	Connect 2 devices suing LPWAN (Smart Meter)	CO-4	70	20	10
30.	Connect 2 or more devices using RFID	CO-4	70	20	10
31.	Identify a problem and develop an app	CO-5	70	20	10

Legend:
  PRA*: Process Assessment
  PDA**: Product
  Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Suggested Instructional/ Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Toolsand Software	Broad Specifications	Relevant Experiment/Practic alNumber
1	Python software	Openly available as per instruction	As mentioned above list
2	Cables connecters and crimping tools	Cat 6e cable, RJ-45 connectors and Crimping Tool	
3	Bluetooth and infrared devices	Any mobile and wireless keyboard and mouse	
4	IoT free cloud	Free available	
5	Smart devices	Like meters, bulbs etc.	
6	Wireless access point	Wireless router or access point	
8	Arduino development board	Arduino Uno and Arduino Nano.	
6	Raspberry Pi	Raspberry Pi 4/ Raspberry Pi 3/ Raspberry Pi 2	

R) **Suggested Learning Resources:**

(a) **Books**:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1	Let Us Python	Kanetkar Yashavant	BPB Publications ISBN: 9789388511568, 9789388511568
2	IOT (Internet of things) and Its Application	P K Pandey	T Balaji Publication (1 January 2020) ISBN-10:8194136385 ISBN-13: 978-8194136385
3	Raspberry Pi Cookbook: Software andHardware Problems and Solutions	Simon Monk	Shroff/O'Reilly; Third edition (4 October 2019) ISBN-10: 9352139267 ISBN-13: 978-9352139262
4	Raspberry Pi Cookbook: Software andHardware Problems and Solutions,	Simon Monk	Shroff/O'Reilly; Third edition (4 October 2019) ISBN-10: 9352139267 ISBN-13: 978-9352139262
5	Cloud Computing: Concepts, Technology& Architecture	Erl	Pearson Education India; 1st edition (1 January 2014) ISBN-10: 9332535922 ISBN-13: 978-9332535923
6.	Fundamentals of Internet of Things	Eden Scott	States Academic Press 2023 ISBN 9781649649235

7	Internet of Things	Alaina Wilson	Murphy & Moore Publishing 2023 ISBN 9781649872731
8	Principles of Internet of Things	Hallie Parker	Larsen and Keller Education 2023 ISBN 9781641728312

(b)   Online Educational Resources:

1. nptel.iitm.ac.in/courses/.../IIT.../lecture%2023%20and%2024.htm
2. en.wikipedia.org/wiki/Shear_and_moment_diagram
3. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
4. www.engineerstudent.co.uk/stress_and_strain.html
5. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
6. https://www.veritis.com/blog/aws-vs-azure-vs-gcp-the-cloud-platform-of-your-choice/
7. https://wiki.python.org/moin/TimeComplexity
8. www.engineerstudent.co.uk/stress_and_strain.html
9. https://www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf
   Amini, P. (2014). Sulley: Pure Python fully automated and unattended fuzzing frame- work. https://github.com/OpenRCE/sulley

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested OER, before use by the students.

(c)   Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

S)   Course Curriculum Development Team (NITTTR, Bhopal)

Dr. M. A. Rizvi (Coordinator)

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A)	**Course Code**	:	**2000605D/2000608D/2000611D**
B)	**Course Title**	:	Drone Technology (Advanced)
C)	**Pre- requisite Course(s)**	:	Drone Technology (Basics)
D)	**Rationale**	:	

In previous semester, a course in drone technology broadly discussed about basic principles, functions and interface of different components and design simple drone structure. In order to understand the successive development of drones / UAVs in terms of their geometric structure, working methodology and navigation control etc., so it is important to study the advanced course on Drone Technology. This course includes the study of Static and dynamic force analysis on drone, advance flying features, navigation control, maintenance and advance applications of different types of drone.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1 Apply the concept of engineering mechanics for stability of drone.

CO-2 Design the structure of drone using GPS module and thermal Image camera.

CO-3 Operate drone using advance flight controller board.

CO-4 Perform drone maintenance and assembly.

CO-5 Use drone in advance applications like precision agriculture, security, IoT, etc.

F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes(COs)	Programme Outcomes(POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	-	-	-	-	-		
CO-2	2	2	-	3	3	-	-		
CO-3	2	2	3	3	-	-	-		
CO-4	3	-	-	3	-	-	-		
CO-5	-	2	2	-	-	3	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs isoptional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction(LI)	Notional Hours (TW+SL)	Total Hours (CI+LI+TW+SL)	Total Credits(C)
			L	T				
	2000605D/2000608D/2000611D	Drone Technology (Advance)	03	-	04	02	09	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedbackof teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)							Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment(TWA)		Lab Assessment(LA)			
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)		
	2000605D/2000608D/2000611D	Drone Technology (Advance)	30	70	20	30	20	30		200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

☐ Separate passing is must for progressive and end semester assessment for both theory and practical.

☐ ETA & ELA are to be carried out at the end of the term/ semester.

☐ Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty

should prepare checklist & rubrics for these activities.

I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction(LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of TheorySession Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs)upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must beintegrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units:**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number (s)
TSO 1a. Draw free body diagram of quadcopter drone. TSO 1b. Determine centroid of given drone structure. TSO 1c. Determine center of gravity of different drone structure. TSO 1d. Analyze different types of force acting drone system. TSO 1e. Differentiate between static and dynamic force analysis. TSO 1f. Explain how gyroscopic motion keepsdrone balanced and hovering.	**Unit-1.0 Engineering mechanics for Dronetechnology** 1.1 Drone Mechanics • Free body diagram of drone • Method of finding resultant of force system • Equilibrium of coplanar force system 1.2 Center of Gravity • Centroid of plane figure • Center of gravity of solid bodies 1.3 Force analysis in drone • Force analysis in drone • Forces of flight • Principle axes and rotation of aerial systems 1.4 Dynamics of machine • Static and dynamic force analysis • Gyroscopic motions	**CO-1**
TSO 2a. Describe properties and application of smart materials use in UAV frame. TSO 2b. Calculate the diameter of the propeller for given drone frame size. TSO 2c. Determine size of quadcopter frame and diameter of propeller of drone TSO 2d. Describe working of GPS and its hardwareinterfacing. TSO 2e. Write steps to interface GPS module for drone navigation. TSO 2f. Describe different RF blocks and antennas used in RF transmitter and receiver.	**Unit-2.0 Drone Frame and components** 2.1 Drone frame design ◻ Calculation principle for drome frame sizes ◻ Quadcopter frame design ◻ Smart materials for UAV frame ◻ Green material uses in drone 2.2 Advance Drones component • GPS, Interfacing of GPS hardware • Thermal and chemical sensor • Tilt and LiDAR sensor 2.3 RF transmitter and receiver • RF blocks • RF antennas 2.4 Micro-electromechanical systems (MEMS) based sensor 2.5 HD and thermal Image camera	**CO-2**
TSO 3a. Identify features and specifications of FCBuse in different application	**Unit-3.0 Advance flight controller Board (FCB)**	**CO-3**

Major Theory Session Outcomes (TSOs)		Units	Relevant COs Number (s)

TSO
3b.
	Explain ports of any given advance flightcontroller board.
	Write steps of software installation of flight controller board.
		3.1 Specification and ports of FCB
		3.2 Software for FCB
		   ☐ Software installation
		3.3 Radio Communication with FCB
		   ☐ Installation of Radio Telemetry
		   ☐ Radio Calibration with FCB
		3.4 Calibration of accelerometer
		3.5 Calibration of ESC
		3.6 Interface of motor with FCB using ESC
		3.7 GPS interface with FCB
		3.8 Safety features of advance FCB	

TSO 3c. TSO 3d. TSO 3e. TSO 3f.	Describe installation and calibration steps of radio telemetry with FCB. Write steps of calibration of accelerometer and ESC with FCB. Describe interfacing of GPS with FCB.		

TSO
4a. TSO
4b.
 	
TSO
 	
4c. TSO
 	
4d.
	Describe challenges comes in drone maintenance.
	Describe measuring devices and instrument use in drone maintenance.
	Describe measuring instrument used to measure electrical parameters in drone.
	Write sequence of steps use in assembling of drone.
		Unit-4.0 Maintenance and assembling of Drone
		
		4.1 Need and scope of drone maintenance
		4.2 Types of maintenance
		4.3 Routine drone maintenance and its checklist
		   • Recording basic details
		   • Structural inspection
		   • Battery check
		   • Software/firmware
		4.4 Types of measuring instrument use in drone maintenance
		4.5 Measurement of different electrical parameters related with drone hardware
		4.6 Assembly of drones
		   • Concept of interchangeability
		   • Principle of gauging and their applicabilityin drone assembly
		   • Parameters and profile measurements of standard propellers
		   • Concepts of drone assembly using 3D modeling
			CO-4

TSO
5a. TSO
5b.
 	
TSO
 	
5c.
	Describe function of autonomous drone using AI.
	Describe IoT enable UAV for surveillanceand data gathering.
	Explain drone applications based on cost saving, enhanced efficiency and profitability aspects.
		Unit-5.0 Advance Drone Application
		
		5.1 Application of AI in Drone Technology
		5.2 IoT and Computer vision integrated Drone
		5.3 Drone interface with smart-phone
		5.4 Drone Applications in
		   • Military
		   • Precision Agriculture
			CO-5

Note: One major TSO may require more than one theory session/period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical (2000608D):

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1 Use the force of gravity to compute the centre of gravity for a given drone structure.	1.	Determine Centre of gravity of different done structure.	**CO-1**
LSO 2.1 Develop skills of observation and interpreting phenomenal changes on Drone model for stability and hovering.	2.	Demonstrate gyroscopic effect on a drone model	**CO-1**
LSO 3.1 Draw various frame to be required in designing drone structure. LSO 3.2 Use Measuring instrument in designing drone frame. LSO 3.3 Choose suitable materials for making drone frame	3.	Compare different types of airframe structure like quadcopter frame (plus shape, cross shape and H-shape), hexacopter frame (hexa + and hexa S).	**CO-2, CO-4**
LSO 4.1 Identify and measure the condition of sensors. LSO 4.2 Interface Tilt and LiDAR sensors in drone.	4.	Test Tilt and LiDAR sensors and their characteristics with Microcontroller based Flight controller board.	**CO-2**
LSO 5.1 Identify different component of GPS module LSO 5.2 Measure and use signals from GPS module to determine latitude & longitude. LSO 5.3 Diagnose problems using appropriate instruments/tools related to GPS navigation.	5.	Demonstrate the interfacing of GPS module to drone navigation.	**CO-2, CO-3**
LSO 6.1 Measure characteristics of HD and thermal Image camera. LSO 6.2 Diagnose common problems related to HD and thermal Image camera.	6.	Test HD and thermal Image camera and their characteristics.	**CO-2**
LSO 7.1 Identify the characteristics of RF circuit blocks like amplifier, and filters. LSO 7.2 Identity different antennas used. LSO 7.3 Operate drone using RC transmitter and receiver.	7.	Identify, configure and operate 433MHz and 2.4 GHz RC transmitter and receiver.	**CO-2**
LSO 8.1 Test the different peripheral interconnections with FCB LSO 8.2 Troubleshoot advance Flight control board (FCB)	8.	Programming and configure of parameters in flight control board (FCB).	**CO-3**
LSO 9.1 Configure radio communication device to control drones. LSO 9.2 Operate drone using RC transmitter and receiver.	9.	Test and perform communication of advance Flight control board with RF transceiver.	**CO-3, CO-2**
LSO 10.1 Measure various parameters of GPS system LSO 10.2 Interface GPS system with flight controller board.	10.	Test and perform communication of Flight control board (FCB) with GPS	**CO-3, CO-2**
LSO 11.1 Configure HD and thermal image camera with drone. LSO 11.2 Demonstrate use of HD and thermal image camera with FCB	11.	Test and troubleshoot HD and thermal image camera with advance FCB in drone.	**CO-3, CO-2**

LSO 12.1 Measure voltage, current frequency using Digital Multimeter LSO 12.2 Measure peak to peak voltage, time period, and duty cycle using DSO and waveform generator.	12.	Measure various electric parameters in drone hardware	**CO-4**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 12.3 Measure unknown frequency and its level using spectrum analyzer.			
LSO 13.1 Inspect drone as per the given checklist LSO 13.2 Diagnose drone problems after flying of 50 and 100hrs	13.	Perform preventive maintenance of drone components	**CO-4**
LSO 14.1 Perform dismantle process of drone. LSO 14.2 perform services need for operation LSO 14.3 Check and Install different parts of thedrone system. LSO 14.4 Assemble drone component.	14.	Dismantle and service of different parts of drone system	**CO-4**

L)   Suggested Term Work and Self Learning (2000611D): Some sample suggested assignments, micro projectand other activities are mentioned here for reference.

a.   Assignments: Questions/Problems/Numerical/Exercises to be provided by the course teacher in linewith the targeted COs.

b.   Micro Projects:

1. Prepare maintenance report for small UAV.
2. Survey nearby electronics shop and Prepare report on types of drone frames and drone sensorsavailable and its specification.
3. Prepare report of surveying & mapping of our institute using drone with HD and thermal image camera.
4. Prepare report on land and crops quality of nearby agriculture field using drone.
5. Prepare report on Identify and select different application drones like agriculture, Surveillance, Inspections and gathering Information for disaster management.
6. Download 5 videos on advance FCB of drone design. Watch them and write report on it.
7. Market survey on different types of FCB, its specification and specific application and prepare report.
8. Develop mission completion drone with the help of GPS based Advance FCB.

c.   Other Activities:

1. Seminar Topics-Drone stability using gyroscopic motion, Quadcopter frame, Green material use in drone design, GPS based drones, types of HD and thermal Image camera, Safety features in advance drone, Drone Assembling, Military drone.
2. Visits: Visit nearby small industry, Drone institute facilities. Prepare report of visit with special comments of advance drone technology used, material used, cost of printed component.
3. Surveys: Survey nearby electronics shop and Prepare report of list of advance drone components and its specification.
4. Product Development
5. Software Development

d.   Self-learning topics:

1. Different types Drones frame
2. Overview of GPS technology
3. Different types of HD and thermal Image camera
4. Safety features in Drone
5. Advance drone application

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	20%	20%	20%	25%	25%
CO-2	20%	20%	20%	20%	20%	25%	25%
CO-3	25%	25%	20%	20%	20%	25%	25%
CO-4	25%	25%	20%	20%	20%	25%	25%
CO-5	15%	15%	20%	20%	20%	-	-
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*:   Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
**:   Mentioned under point- (N)
#:   Mentioned under point-(O)
Note:
- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Suggested Specification Table for End Semester Theory Assessment:** Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction(CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember(R)	Understanding(U)	Application & above (A)
Unit 1.0 Engineering mechanics for Drone Technology	8	CO-1	12	04	04	04
Unit 2.0 Drone frame and components	10	CO-2	14	04	04	06
Unit 3.0 Advance Flight Controller Board	12	CO-3	16	04	06	06
Unit 4.0 Maintenance and assembling of drone	10	CO-4	16	04	06	06
Unit 5.0 Advance Drone Application	8	CO-5	12	04	04	04
Total Marks	**48**		**70**	**20**	**24**	**26**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Suggested Assessment Table for Laboratory (Practical):**

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA Performance PRA* (%)	PDA** (%)	Viva-Voce (%)
1.	Determine Centre of gravity of different done structure.	CO-1	50	40	10
2.	Demonstrate gyroscopic effect on a drone model	CO-1	40	50	10
3.	Compare different types of airframe structure like quadcopter frame (plus shape, cross shape and H-shape), hexacopter frame (hexa + and hexa S).	CO-2	50	40	10
4.	Test Tilt and LiDAR sensors and their characteristics with Microcontrollerbased Flight controller board.	CO-2	50	40	10
5.	Demonstrate the interfacing of GPS module to drone navigation.	CO-2, CO-3	50	40	10
6.	Test HD and thermal Image camera and their characteristics.	CO-2	50	40	10
7.	Identify, configure and operate 433MHz and 2.4 GHz RC transmitter and receiver.	CO-2	60	30	10
8.	Programming and configuration of parameters in flight control board (FCB).	CO-3	60	30	10
9.	Test and perform communication of advance Flight control board with RF transceiver.	CO-3, CO-2	60	30	10
10.	Test and perform communication of Flight control board (FCB) with GPS	CO-3, CO-2	60	30	10
11.	Test and troubleshoot HD and thermal image camera with advance FCB in drone.	CO-3, CO-2	60	30	10
12.	Measure various electric parameters in drone hardware	CO-4	40	50	10
13.	Perform preventive maintenance of drone components	CO-4	60	30	10
14.	Dismantle and service of different parts of drone system	CO-4	60	30	10

Legend:
PRA*: Process Assessment
PDA**: Product
Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q)   List of Major Laboratory Equipment, Tools and Software:

S. No.	Name of Equipment, Tools andSoftware	Broad Specifications	Relevant Experiment/Practical Number
1.	Drone Frame	Tricopter/Quadcopter/Hexacopter	1-15
2.	Propellers	15 X 5.5 CW/Others	1-15
3.	GPS module	M8N Series	1-15
4.	Drone Camera	15-20 Megapixel	1-15
5.	Camera Gimble	3 Axis feature, 360 Degree movement	1-15
6.	Tilt Sensor	8-30 volt	1-15
7.	LiDER sensor	Range 75m to 200m	1-15
8.	Battery	Lithium Polymer Battery,8000 to 10000 mAh	1-15
9.	Motor	BLDC, 370kv	1-15
10.	Electronic speed Controller (ESC)	40 Amp	1-15
11.	Flight Controller Board	CC3D/Pixhawk/Others	1-15
12.	Transmitter and Receiver for radio signal	10 Channels and more, 2.4 GHz & 5.8 GHz	1-15
13.	Embedded system for AI application on UAV	Open Source Jetson Baseboard /Others	1-15

R)   Suggested Learning Resources:

(a)   Books:

S. No.	Titles	Author (s)	Publisher and Edition with ISBN
1.	Make: DIY Drone and Quadcopter Projects: A Collection of Drone-Based Essays, Tutorials, and Projects	Editors of Make	Shroff/Maker Media, First edition 2016,ISBN-978-9352133994
2.	Make: Getting Started with Drones: Build andCustomize Your Own Quadcopter	Terry Kilby & BelindaKilby	Shroff/Maker Media, First edition 2016,ISBN-978-9352133147
3.	Agricultural Drones: A Peaceful Pursuit	K R Krishna	Apple Academic Press,1st edition 2018,ISBN-978-1771885959
4.	Building Multicopter Video Drones: Build and fly multicopter drones to gather breathtaking videofootage	Ty Audronis	Packt Publishing Limited; Illustratededition,2014, ISBN-978-1782175438
5.	The Complete Guide to Drones	Adam Juniper	Ilex Press, Extended 2nd Edition,2018ISBN-9781781575383
6.	Unmanned Aircraft Systems - UAVS Design, Development and Deployment (Aerospace Series)	R Austin	John Wiley & Sons Inc, 1st edition, 2010,ISBN-978-0470058190
7	Drone Technology	Miranda Hall	NY Research Press 2023 ISBN 9781632389574

8	Introduction to UAV Systems	Rupert Baker	Willford Press 2023 ISBN 9781682860890
9	Theory, Design, and Applications of Unmanned Aerial Vehicles	Tyler Wood	Larsen and Keller Education 2023 ISBN 9781641728338

(b) **Online Educational Resources:**

1. https://archive.nptel.ac.in/courses/101/104/101104083/
2. https://onlinecourses.nptel.ac.in/noc21_ae14/preview
3. https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle
4. https://fusion.engineering/
5. https://robocraze.com/blogs/post/best-flight-controller-for-drone
6. https://www.youtube.com/watch?v=lrkFG7GilPQ
7. https://www.youtube.com/watch?v=KjG6FKCNCbM
8. https://ardupilot.org/
9. https://px4.io/

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) **Others:**

1. Development of an Autonomous IoT-Based Drone for Campus Security, Abdelrahman Mahmoud Gaber, Rozeha A. Rashid, Nazri Nasir, Ruzairi Abdul Rahim, M. Adib Sarijari, A. Shahidan Abdullah, Omar A. Aziz, Siti Zaleha A. Hamid, Samura Ali,2021
2. IoT based UAV platform for emergency services; S. K. Datta, J. L. Dugelay, & C. Bonnet, 2018
3. Development of an Autonomous Drone for Surveillance Application; M. A. Dinesh, S. SanthoshKumar, J. Sanath, K. N. Akarsh & K. M. Manoj Gowda,2018
4. Autonomous cloud-based drone system for disaster response and mitigation; C. Alex & A. Vijaychandra,2016
5. https://www.geeetech.com/Documents/CC3D%20flight%20control%20board.pdf
6. https://www.bhphotovideo.com/lit_files/201146.pdf
7. http://tricopter.hu/docs/cc3d_manual.pdf

S) **Course Curriculum Development Team (NITTTR, Bhopal)**

☐ Dr. K. K. Jain (Coordinator)
☐ Dr. Sanjeet Kumar (Co-coordinator)

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A)	Course Code	: **2000605E/2000608E/2000611E**
B)	Course Title	: 3D Printing and Design (Advance)
C)	Pre- requisite Course(s)	: 3D Printing and Design (Basic)
D)	Rationale	:

This advanced course on 3D Printing tries to develop understanding of the process of making real complex objects from digital models in the students using various 3D printing processes and materials (Plastics, Ceramics and Metals). It also covers the post processing required and details about various printing process and parameters to make a quality 3D printed component. This course can only be taken up after completing 3D Printing and Design (Basic) course offered in previous semester.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1   Select newer 3D Printing material for various applications.
CO-2   Use solid based 3D Printing processes to develop products.
CO-3   Use liquid-based 3D Printing processes to develop products.
CO-4   Use powder-based 3D Printing processes to develop products.
CO-5   Apply post processing techniques and quality checks on 3D printed components.

F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes(COs)	Programme Outcomes(POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2
CO-1	3	-	-	-	2	-	2		
CO-2	3	-	2	2	-	-	2		
CO-3	3	-	2	2	-	-	2		
CO-4	3	-	2	2	-	-	2		
CO-5	3	2	-	3	2	-	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)
* PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) **Teaching & Learning Scheme:**

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction (CI)		Lab Instruction(LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+SL)	Total Credits(C)
			L	T				
	2000605E /2000608E /2000611E	3D Printing and Design (Advanced)	03	-	04	02	09	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work &Self-Learning Assessment (TWA)		Lab Assessment(LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive LabAssessment (PLA)	End Laboratory Assessment (ELA)	
	2000605E /2000608E /2000611E	3D Printing and Design (Advanced)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

☐ Separate passing is must for progressive and end semester assessment for both theory and practical.

☐ ETA & ELA are to be carried out at the end of the term/ semester.

☐ Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) **Course Curriculum Detailing:** This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self-Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) **Theory Session Outcomes (TSOs) and Units:**

Major Theory Session Outcomes (TSOs)	Units	Relevant tCOs Number(s)
TSO 1a. Explain various forms of 3D printing raw material. *TSO 1b.* Select material for the given popular 3D printing processes with justification. *TSO 1c.* Select various Polymer based 3D printing raw materials with justification. *TSO 1d.* Explain procedure of Powder preparation for the given 3D printing material. *TSO 1e.* Explain properties of the given Metal/Ceramics 3D printing material. *TSO 1f.* Choose suitable 3D printing material on the basis of Performance Requirements and Material Properties.	**Unit-1.0 3D Printing Materials** 1.1 Various forms of 3D printing raw material-Liquid, Solid, Wire, Powder. 1.2 Popular FDM, SLA, SLS, Binder Jetting, Material Jetting and Direct Energy deposition 3D printingmaterials. 1.3 Polymers, Metals, Non-Metals, Ceramics. 1.4 Polymers and their properties. 1.5 Powder Preparation and their desired properties. 1.6 Choosing the Right 3D Printing Material on the basis of Performance Requirements and Material Properties.	**CO1**
TSO 2a. Explain working of a typical FDM based 3D Printer. *TSO 2b.* Justify use of FDM based 3D printing processand material for the given component. *TSO 2c.* Explain the Laminated Object Manufacturing process. *TSO 2d.* Estimate the cost and time of the given FDM based 3D printed component.	**Unit-2.0 Solid based 3D Printing Processes** 2.1 Basic principle and working of fused depositionmodeling (FDM) process. 2.2 Liquefaction, solidification and bonding. 2.3 Laminated Object Manufacturing process. 2.4 Cost estimation of FDM 3D printed component.	**CO1, CO2**
TSO 3a. Explain the phenomenon of Photo Polymerization. *TSO 3b.* Explain the working of a typical Stereo Lithography based 3D Printer. *TSO 3c.* Explain procedure of 3D Scanning of the given component. *TSO 3d.* Justify use of SLA based 3D printing process and material for the given component. *TSO 3e.* Estimate the cost and time of the given SLA based 3D printed component. *TSO 3f.* Apply Curing process to SLA based 3D printed component.	**Unit-3.0 Liquid based 3D Printing Processes** 3.1 Photo polymerization. 3.2 Principle and working of stereo lithography apparatus. 3.3 SLA based 3D printing processes. 3.4 SLA based 3D printing process materials. 3.5 Scanning techniques. 3.6 Curing processes. 3.7 Cost estimation of SLA 3D printed component.	**CO1, CO3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 4a. Explain powder fusion mechanism. *TSO 4b.* Explain working of a typical SLA based 3D Printer. *TSO 4c.* Justify use of SLA based 3D printing process and material for the given component. *TSO 4d.* Explain Net shape process. *TSO 4e.* Explain Binder Jet 3D printing process. *TSO 4f.* Justify use of Binder Jet 3D printing process and material for the given component. *TSO 4g.* Estimate the cost and time of the given SLS based 3D printed component.	**Unit-4.0 Powder based 3D Printing Processes** 4.1 Powder fusion mechanism. 4.2 Principle and working of Selective LaserSintering (SLS) process. 4.3 SLS based 3D printers. 4.4 Laser Engineering Net Shaping process. 4.5 Electron Beam Melting. 4.6 Binder Jet 3D Printing. 4.7 Materials and Process parameters for SLS based 3D printing processes. 4.8 Cost estimation of SLS based 3D printedcomponent.	**CO1, CO4**
TSO 5a. Justify the need of post processing in the given 3D printed component. *TSO 5b.* List the various post processing techniques. *TSO 5c.* List the steps to perform post processing. *TSO 5d.* Explain the given Cleaning related post processing approach for 3D printed component. *TSO 5e.* Explain the given Surface finishing related post processing approach for 3D printed component. *TSO 5f.* Apply simple inspection and testing techniques on the given 3D printed component. *TSO 5g.* Identify the type of defect(s) in the given 3D printed component.	**Unit-5.0 Post Processing and Quality** 5.1 Need of post processing: Functional and Aesthetic reasons. 5.2 Steps of Post Processing: Cleaning/Support removal, Fixing, Curing or hardening, Surfacefinishing, Colouring. 5.3 Cleaning: Support Removal (FDM and Material Jetting); Powder Removal (SLS and Powder BedFusion); Washing (SLA and Photo polymerisation). 5.4 Fixing: Filling, Gluing, Welding. 5.5 Surface finishing: Sanding, Polishing, Tumbling,Hydro dipping, Epoxy coating, Electro Plating, Vapour smoothing-Acetone treatment. 5.6 Colouring, Coating, Priming and Painting. 5.7 Inspection and testing: Digital, Visual, Physical. 5.8 Defects and their causes.	**CO1, CO2, CO3, CO4, CO5**

Note: One major TSO may require more than one Theory session/Period.

K)   Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical (2000608E):

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 1.1. Use the available 3D printing software. *LSO 1.2.* Select printing process parameters based on the type/make of Printer and raw material *LSO 1.3.* Set printing process parameters. *LSO 1.4.* Produce a complex component using available FDM Printer.	1.	Develop the assigned digital single complex component using FDM based 3D Printer and available material.	**CO1, CO2**
LSO 2.1. Use the available 3D printing software. *LSO 2.2.* Select printing process parameters based on the type/make of Printer and raw material *LSO 2.3.* Set printing process parameters. *LSO 2.4.* Produce a complex component using	2.	Develop the assigned digital single complex component using SLA based 3D Printer and available material.	**CO1, CO3**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
available SLA Printer. *LSO 2.5.* Perform curing of the SLA based 3Dprinted component.			
LSO 3.1. Use the available 3D printing software. *LSO 3.2.* Select printing process parameters based on the type/make of Printer and raw material *LSO 3.3.* Set printing process parameters. *LSO 3.4.* Produce a complex component using available SLS Printer.	3.	Develop the assigned digital single complex component using SLS based 3D Printer and available material.	**CO1, CO4**
LSO 4.1. Use the available 3D printing software. *LSO 4.2.* Select printing process parameters based on the type/make of Printer and raw material *LSO 4.3.* Set printing process parameters. *LSO 4.4.* Produce a complex component using available FDM, SLA and SLS Printer. *LSO 4.5.* Perform Cost, Time, Surface finish and Strength estimations related to 3D printed components.	4.	Develop same digital single complex component using FDM, SLA and SLS based 3D Printers and compare the printed componentson the basis of Cost, Time, Surface finish, Strength.	**CO1, CO2, CO3, CO4**
LSO 5.1. Use the available 3D printing software. *LSO 5.2.* Select printing process parameters based on the type/make of Printer and raw material *LSO 5.3.* Select appropriate tolerance, fit and printing process parameters. *LSO 5.4.* Produce an assembly using available SLA/SLS Printer.	5.	Print one digital assembly on SLA/SLS based 3D Printer.	**CO2/CO3 /CO4**
LSO 6.1. Use of available 3D scanner. *LSO 6.2.* Develop 3D digital model using scanningapproach. *LSO 6.3.* Use the available 3D printing software. *LSO 6.4.* Produce a complex component using available SLA Printer.	6.	Scan the given real complex component and print it using FDM/SLA/SLS based 3D Printer.	**CO2, CO3, CO4**
LSO 7.1. Identify tools/devices/chemicals for post processing *LSO 7.2.* Perform post processing operations on printed component.	7.	Apply post processing techniques on the 3D printed component of experiment number 1 and/or 2 and/or 3.	**CO5**
LSO 8.1. Identify tools/devices/techniques for inspection and testing. *LSO 8.2.* Identify the defects in 3D printed components *LSO 8.3.* Apply remedial measures to bring soundness in the defective 3D printed component.	8.	Check the soundness of the 3D printed component of experiment number 1 and/or 2 and/or 3 using available devices/techniques.	**CO5**

L) **Suggested Term Work and Self Learning (2000611E):** Some sample suggested assignments, micro projectand other activities are mentioned here for reference

a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

b. **Micro Projects:**

   1. Prepare a list of solid, liquid and powder form 3D printing raw materials stating their cost, colour opacity, flexibility and weight per unit volume.
   2. Download 5 videos of 3D printing of different components using FDM, SLA and SLS each. Watch them and write a report to detail out the steps involved, 3D Printer used, 3D Printing software used, material used, complexity involved, printing time, post processing steps used.
   3. Prepare a report on post processing steps and techniques used for 3D printed components using FDM, SLA, SLS.
   4. Prepare a report to compare FDM, SLA, SLS based 3D printing process on the basis of cost, surface finish, printer setting time, printing time and post processing time and cost involved.
   5. Download 5 videos of 3D printing processes **other than** FDM, SLA and SLS. Watch them and write a report to detail out the steps involved, 3D Printer used, 3D Printing software used, material used, complexity involved, printing time, post processing steps used.
   6. Download 1 video related to inspection and testing of 3D printed components using different techniques like Visual inspection, Scanning Electron Microscopy (SEM), CT system, X-ray, Penetration testing, Infrared thermography, Leak or pressure testing for complex structures, Eddy current, Mechanical property inspection to measure tensile, yield, shear, fatigue, hardness, density, impact strength, Metallography (Microstructure testing). Watch them and write a report to detail out the steps involved and equipment used.

c. **Other Activities:**

   1. Seminar Topics:
      - Newer 3D printing raw materials
      - Direct energy 3D printing process
      - Material jetting 3D printing process
      - Micro 3D printing process
      - Metal and Ceramic 3D printing
      - 3D printing of Jewelry
      - 3D printing of Bio implants
      - Printing of flexible plastic components

   2. Visits: Visit nearby tool room/industry with 3D Printing facilities. Prepare report of visit with special comments of 3D printing technique used, material used, single component/batch production/mass production and cost of printed component.

   3. Self-learning topics:
      - 3D printing of transparent, soft and flexible plastic components
      - 3D printing of metal components
      - 3D printing of ceramic components
      - 3D scanning process.
      - Chemical post processing techniques

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

Course Evaluation Matrix		
Theory Assessment (TA)**	Term Work Assessment (TWA)	Lab Assessment (LA)#

COs	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	15%	15%	15%	-	-	10%	20%
CO-2	20%	20%	20%	25%	25%	25%	20%
CO-3	20%	20%	20%	25%	25%	25%	20%
CO-4	20%	20%	20%	25%	25%	25%	20%
CO-5	25%	25%	25%	25%	25%	15%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.

**: Mentioned under point- (N)

#: Mentioned under point-(O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions relatedto achievement of each COs.

N) **Suggested Specification Table for End Semester Theory Assessment:** Specification table represents thereflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction(CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember(R)	Understanding(U)	Application& above (A)
Unit-1.0 3D Printing Materials	6	CO1	10	3	2	5
Unit-2.0 Solid based 3D PrintingProcesses	10	CO1, CO2	14	4	5	5
Unit-3.0 Liquid based 3D PrintingProcesses	10	CO1, CO3	14	4	5	5
Unit-4.0 Powder based 3D Printing Processes	10	CO1, CO4	14	4	5	5
Unit-5.0 Post Processing and Quality	12	CO1, CO2, CO3, CO4, CO5	18	5	5	8
Total	**48**	**-**	**70**	**20**	**22**	**28**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) **Suggested Assessment Table for Laboratory (Practical):**

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
1.	Develop the assigned digital single complex component using FDM based 3D Printer and available material.	CO1, CO2	30	60	10

2.	Develop the assigned digital single complex component using SLA based 3D Printer and available material.	CO1, CO3	30	60	10
3.	Develop the assigned digital single complex component using SLS based 3D Printer and available material.	CO1, CO4	30	60	10
4.	Develop same digital single complex component using FDM, SLA	CO1, CO2,	30	60	10

SN	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA* (%)	PDA** (%)	
	and SLS based 3D Printers and compare the printed components on the basis of Cost, Time, Surface finish, Strength.	CO3, CO4			
5.	Print one assembly on SLA/SLS based 3D Printer.	CO2/CO3 /CO4	30	60	10
6.	Scan the given real complex component and print it using FDM/SLA/SLS based 3D Printer.	CO2, CO3, CO4	40	50	10
7.	Apply post processing techniques on the 3D printed component of experiment number 1 and/or 2 and/or 3.	CO5	40	50	10
8.	Check the soundness of the 3D printed component of experiment number 1 and/or 2 and/or 3 using available devices/techniques.	CO5	40	50	10

Legend:

PRA*: Process Assessment

PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Field Trips, Portfolio Based, Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field Information and Communications Technology (ICT)Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Session, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment,Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
1.	High end computers	Processor Intel Core i7 with Open GL Graphics Card, RAM 32 GB, DDR3/DDR4, HDD 500 GB, Graphics Card NVIDIA OpenGL 4 GB, OS Windows 10	All
2.	Parametric Computer Aided Design software	CATIA/Solid works/NX/Creo **OR** Available with CoE	1 to 5
3.	FDM based 3D printer	Fused Deposition Modelling system with complete accessories; Build Volume-300 x 300 x 300mm or Higher; Layer Thickness-0.1 – 0.4 **OR** Available with CoE	1,4,5,6
4.	SLA based 3D printer	Printing Technology: SLA, 145 x 145 x 175mm build volume, Common layer thickness 25–100 µm, Dimensional Accuracy ± 0.5% (lower limit: ±0.10 mm), cure time of only 1-3s per layer, Material type: UV-sensitive liquid resin, Curing unit.	2,4,5,6
5.	SLS based 3D printer	Printing Technology: SLS., Build Volume: 130 x 130 x 180 mm, Recommended min. wall thickness: 0.8 mm, Powder Diameter: 60 Microns, Material Type: Nylon, TPU, Light Source: Laser Diode	3,4,5,6
6.	3D Printing Material	ABS/PLA, Resin based Photosensitive material, Polymer/metal/ceramic powder **OR** Available with CoE	1,2,3,4,5,6
7.	3D Printing software	Latest version of software like: Cura/PrusaSlicer/ideaMaker/Meshmixer/MeshLab **OR** Available with CoE	1 to 6

| 8. | 3D Scanner and Processing software | Handheld 3D scanner, Accuracy up to 0.1 mm, Resolution up to 0.2 mm, Real time onscreen 3D model projection and processing, Wireless technology with an inbuilt touch screen and battery, Extended field of view for capturing both large and small objects, Processing Software **OR** Available with CoE | 6 | |

S. No.	Name of Equipment,Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
9.	Post processing equipments and tools	Deburring tools (tool handle & deburring blades), Electronic DigitalCaliper, Cleaning Needles, Art knife set, Long nose pliers, Flush cutters, Wire brush, Nozzle cleaning kit, Tube cutter, Print removalspatula, Needle file, Cutting mat, Glue stick, Wire stripper, Chemicals, Etching agents etc.	7
10.	Inspection and Testing devices	• Visual inspection,Devices related to: • Scanning electron microscopy (SEM), CT system, X-ray, • Penetration testing, • Infrared thermography, • Leak or pressure testing for complex structures, • Eddy current, • Mechanical property inspection to measure tensile, yield, shear, fatigue, hardness, density, impact strenght • Metallography (Microstructure testing)	8

R)   Suggested Learning Resources:

(a)   Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Additive Manufacturing Technologies: RapidPrototyping to Direct Digital Manufacturing	Lan Gibson, David W.Rosen, Brent Stucker	Springer, 2010 ISBN: 9781493921133
2.	Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing	Andreas Gebhardt,	Hanser Publisher, 2011 ISBN: 156990507X, 9781569905074
3.	3D Printing and Design	Sabrie Soloman	Khanna Publishing House, DelhiISBN: 9789386173768
4.	3D Printing and Rapid Prototyping- Principlesand Applications	C.K. Chua, Kah Fai Leong	World Scientific, 2017 ISBN: 9789813146754
5.	Getting Started with 3D Printing: A Hands-onGuide to the Hardware, Software, and Services Behind the New Manufacturing Revolution	Liza Wallach Kloski, Nick Kloski	Make Community, LLC; 2nd edition,2021 ISBN: 9781680450200
6.	Laser-Induced Materials and Processes for Rapid Prototyping	L. Lu, J. Fuh, Y.S. Wong	Kulwer Academic Press, 2001ISBN: 9781461514695
7.	3D Printing: A Practical Guide	Clay Martin	Larsen and Keller Education 2023 ISBN 9781641728323
8.	Fundamentals of 3D Printing	Elizah Brooks	Clanrye International 2023 ISBN 9781647290943
9.	Principles of 3D Printing	Brady Hunter	NY Research Press 2023 ISBN 9781632389549

(b)   Online Educational Resources:

1.   https://onlinecourses.nptel.ac.in/noc21_me115/preview
2.   https://archive.nptel.ac.in/courses/112/104/112104265/
3.   https://bigrep.com/post-processing/
4.   https://www.mdpi.com/2227-7080/9/3/61
5.   https://all3dp.com/2/best-3d-printing-books/
6.   https://www.youtube.com/watch?v=TQY2lF-sFaI

7. https://www.youtube.com/watch?v=Oz0PoS5LPxg
8. https://www.youtube.com/watch?v=6ejjh0GdyDc

(c)   **Others:**

1. 3D Printing Projects DK Children; Illustrated edition, 2017
2. The 3D Printing Handbook: Technologies, design and applications Ben Redwood, Filemon Schöffer, Brian Garret, 3D Hubs; 1st edition, 2017
3. https://www.improprecision.com/inspection-method-for-3d-printed-parts/
4. 3D Printer Users' Guide
5. 3D Printer Material Handbook
6. Lab Manuals

S)   **Course Curriculum Development Team (NITTTR, Bhopal)**

- Dr. Sharad Pradhan (Coordinator)
- Dr. A. K. Sarathe (Co-coordinator)

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A)	**Course Code**	: **2000605F/2000608F/2000611F**			
B)	**Course Title**	: Industrial Automation (Advance)			
C)	**Pre- requisite Course(s)**	: Industrial automation (Basic)			

D)   Rationale   :

This course on Advanced industrial automation offers students a hands-on approach to implement industrial control using modern controllers like Programmable Logic Controller (PLC), Distributed Control System (DCS)Supervisory Control and Data Acquisition (SCADA). Students will learn to identify and connect field inputs and outputs; communicate with, and program microprocessor-based controllers. Students will also connect, communicate with, and develop displays for computer-based operator interfaces. Process manufacturers typically employ Distributed Control System (DCS) Supervisory Control and Data Acquisition (SCADA) technologies to monitor and control the operations in their facilities. DCS and SCADA systems are now doing much more than simply monitoring and controlling. The course will enable the students to use of basic instructions and addressing, advanced PLC instructions in Ladder Logic and to identify and troubleshoot the faults in PLC system and do PLC maintenance. This course also introduces the students to industrial automation communications, PLC maintenance and troubleshooting also to become a successful automation engineer.

E)   Course Outcomes (COs): After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able to-

CO-1. Apply the principles of communication for industrial automation.

CO-2. Test the output of the PLC ladder logic programs for the given application

CO-3. Maintain PLC systems

CO-4. Use SCADA for supervisory control and for acquiring data from the field.

CO-5. Develop simple automation systems

F) Suggested Course Articulation Matrix (CAM):

Course Outcomes(COs)	Programme Outcomes(POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	2	2	2	2	-	2		
CO-2	3	3	3	3	-	-	2		
CO-3	3	3	3	3	2	2	2		
CO-4	3	2	2	2	2	2	2		
CO-5	3	2	2	3	2	2	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)

*   PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs isoptional

G)   Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction(CI)		Lab Instruction(LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+ SL)	Total Credits(C)
			L	T				
	2000605F/ 2000608F/ 2000611F	Industrial Automation (Advance)	03	-	04	02	09	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances/ problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, Online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H)   Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)						Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment(TWA)		Lab Assessment(LA)		
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)	
	2000605F/200 0608F/ 2000611F	Industrial Automation (Advance)	30	70	20	30	20	30	200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self -learning, any other student activities etc.

Note:

☐   Separate passing is must for progressive and end semester assessment for both theory and practical.

☐   ETA & ELA are to be carried out at the end of the term/ semester.

☐   Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self -learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I)   Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at course level andsession level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction

(LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J)   Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevan tCOs Number(s)
TSO.1a Describe how does a PLC communicate? TSO.1b Differentiate between parallel and series communication TSO.1c Describe the data transfer mechanism for the given communication protocols. TSO.1d Describe the given communication protocol used in PLC communication. TSO.1e Summarize PLC to PLC communication procedure TSO.1f Describe the common procedure to interface the PLC with other given hardware.	**Unit-1.0 Industrial automation communication and Interfacing** 1.1 Analog and Digital Communications on Plant Floors 1.2 Introduction to Industrial Networking 1.3 RS232-422-485 standards for data communication 1.4 Industrial Ethernet 1.5 Concept of Fieldbus 1.6 MODBUS protocol 1.7 Highway Addressable Remote Transducer (HART) Protocol 1.8 Interfacing of Programmable Logic Controller with other hardware	**CO-1**
TSO.2a Specify the proper I/O addressing format of the given PLC. TSO.2b Explain the use of different relay type instructions for the given operation. TSO.2c Describe how a program is executed with the help of Program Scan cycle TSO.2d Develop ladder logic program using arithmetic functions to perform the given operation. TSO.2e Develop ladder logic programs using logical and comparison instructions to perform the given operation TSO.2f Develop ladder logic programs using on delay, off delay and reset/retentive timer in a given PLC to create a delay in operation. TSO.2g Develop ladder logic programs using Up, Down and UP-down counter in a given PLC to count the number of products	**Unit-2.0 PLC Programming** 2.1 PLC I/O addressing in ladder logic 2.2 PLC programming instructions using ladder logic and relay type instructions 2.3 Program Scan cycle 2.4 PLC arithmetic functions - Addition, subtraction, multiplication, division instructions, increment decrement, trigonometric 2.5 PLC logical functions - AND, OR, XOR, NOT functions, PLC compare and convert functions. 2.6 Programming Timer –Addressing a timer block, status bits, On delay, Off Delay and reset/retentive timer 2.7 Programming Counter- Addressing a counter block, status bits, Up and Down counter, up-down counter, counter examples, register basics 2.8 Develop ladder logic for various simple applications	**CO-2**
TSO.3a Describe Requirements for PLC enclosure. TSO.3b Describe Proper grounding techniques. TSO.3c Describe noise reduction Techniques. TSO.3d Explain preventive maintenance procedure associated with PLC	**Unit-3.0 Installation and maintenance of PLC systems** 3.1 PLC enclosure, grounding requirements, noise generating inductive devices, leaky inputs and outputs, techniques to reduce electrical noise and leakage. 3.2 Introduction to PLC Trouble shooting and maintenance, trouble shooting of hardware and software. 3.3 Diagnostic LED Indicators in PLCs 3.4 Common problems	**CO-3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
==system to reduce environmental impact== TSO.3e Identify faults in the given PLC system TSO.3f Explain the procedure for Troubleshooting PLC system TSO.3g Prepare preventive maintenance plan for the PLC system TSO.3h Use safety equipment's. TSO.3i Follow safe practices	• Internal problems – Check for PLC Power Supply, Emergency Push Button, Power Supply Failure, Battery Failure, Electrical Noise Interference, Verify the PLC Program with the Master Program, Corrupted PLC Memory • External problems - Power failure, faulty grounding and electrical noise interference (RFI or EMI), Status of the Output Modules and their associated Circuitry, Status of the Input Modules and their associated Circuitry, Field Input and Output Devices, Communication Issues. • Environmental Conditions. Check for humidity, temperature, vibration, and noise-level limits specified by its manufacturer 3.5 Troubleshooting of Specific Components of the PLC System • Power Supply Troubleshooting • I/O Modules Troubleshooting • Troubleshooting PLC Program Errors • Troubleshooting the Working Environment of a PLC • Replacement of CPU 3.6 PLC trouble shooting flowchart 3.7 PLC maintenance – PLC maintenance checklist, preventive maintenance procedure, maintenance plan for the PLC system. 3.8 Safety procedure and safety equipment's.	
TSO.4.a Describe the function of given element of a SCADA system. TSO.4.b Interface the given PLC with SCADA system using the given Open Platform Communications (OPC). TSO.4.c Describe the steps to develop a simple SCADA screen for the given industrial application. TSO.4.d Describe the procedure to maintain the SCADA based PLC system for the given application.	**Unit-4.0 SCADA and DCS** 4.1 Introduction, need, benefits and typical applications of SCADA and DCS 4.2 SCADA Architecture - Remote Terminal Units (RTUs), Master Terminal Units, Various SCADA editors, Communication protocols for SCADA 4.3 Comparison of SCADA with DCS 4.4 Interfacing SCADA system with PLC- Typical connection diagram, Object Linking and Embedding for Process Control (OPC) architecture 4.5 Creating SCADA Screen HMI for simple object, Steps for linking SCADA object (defining Tags and items, creating trends etc.,) with PLC ladder program using OPC, configuring simple applications using SCADA: Traffic light control, water distribution, pipeline control, Power generation, transmission and distribution etc. 4.6 Procedure to maintain the SCADA based PLC system.	**CO-3**
TSO.5a Identify different components used for automation in the given system TSO.5b Select automation components for a given situation TSO.5c In the given manufacturing or service industry Identify the areas where automation is possible. ==TSO.5d Prepare plan for sustainable automation as per the requirement.==	**Unit-5.0 Applications of Industrial Automation** 5.1 **Manufacturing-** Industrial Robots- welding robots, pick and place robots, Cabot's, Machine monitoring system, supply chain, Automated assembly system, Flexible Automation and programmable Automation. 5.2 **Health Care-** microscopic robots for medical diagnosis, automated medication dispensing devices, AESOP, ZEUS, RP_7(remote presence 7th generation), DaVinci 5.3 **Defense- guided rockets and missiles,** counter measures, UAV drones, launcher, radar antenna, engagement control system	**CO-5**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
	5.4 **Automobile –B**reak monitoring system, Vehicle tracking system, Rear-view alarm to detect obstacles behind, Four-wheel drive, Traction control system, Dynamic steering response, Anti-lock braking system (ABS) Adaptive cruise control, Adaptive headlamps, Intelligent Parking Assist System, Driverless/Autonomous Cars 5.5 **Agriculture-** harvesters, irrigation systems, plowing machines, self-driving tractors, grain yield sensor 5.6 **Mining-** Mine planning system, mine picture compilation, mine control system, seismic imagining, laser imaging, Rig control system, automated drilling, automated exploration, automated truck	

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical (2000608F):

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 Data communication from PLC to PC and vice versa	1.	Transfer the control data from PLC to PC andvice versa	**CO1**
LSOs 1.2 Establish Communication channels between PLC s.	2.	Transfer the control data from PLC to PLC	**CO1**
LSOs 1.3 Transfer data from sensors to PLC and from PLC to PC.	3.	Transfer the sensor data from sensor to PLC to PLC and PC	**CO1**
LSOs 1.4 Interface the given PLC with a PC ora Laptop	4.	Interface the given PLC with a PC or a Laptop	**CO1**
LSOs 2.1 Identify Different parts and front panel indicators of a PLC	5.	Identify the various parts and front panel status indicators of the given PLC.	**CO2**
LSOs 2.2 Develop Ladder logic program for different arithmetic operations	6.	Develop/Execute ladder logic program for different arithmetic operations such as Addition, subtraction, multiplication, division increment, decrement, trigonometric in a given PLC	**CO2**
LSOs 2.3 Develop Ladder logic program fordifferent logical operations	7.	Develop/Execute ladder logic program for logical operations such as AND, OR, NOT, NAND, NOR, X-OR, X-NOR gate along with truth table	**CO2**
LSOs 2.4 Program Latch and Unlatch circuit in aPLC for motor operation	8.	Program the given PLC to start run and stop the given motor using latch circuit	**CO2**
LSOs 2.5 Create delay in operation using on delay, off delay and retentive timer function in a given PLC.	9.	Test the functionality of on delay, off delay and retentive timer for its correct operation in a given PLC.	**CO2**
LSOs 2.6 Count the number of objects/events using Up counter, Down counter and UP/Down counter in a PLC	10.	Test the functionality of Up, Down and Up-down counter for its correct operation in a given PLC.	**CO2**
LSOs 2.7 Program PLC using ladder logic to controla LED/Lamp	11.	Develop/Execute a ladder logic program to put LED/lamp in the blinking mode	**CO2**
LSOs 2.8 Program PLC using ladder logic to controla simple traffic light system	12.	Develop/Execute a ladder logic program to control a simple traffic light control system using PLC	**CO2**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 3.1 Use hygrometer to measure the humidity inside the panel *LSOs 3.2* Use thermometer to measure ambient temperature inside the panel *LSOs 3.3* Use tester to determine the voltage fluctuation at the power supply terminals is within specifications *LSOs 3.4* Test the ground connections of the given PLC. *LSOs 3.5* A given PLC is not working as per the logic instructions investigate the PLC to identify the cause of failure to show the desired output *LSOs 3.6* Investigate the cause of Noise in the given PLC *LSOs 3.7* PLC goes on blackout out by losing its operating power. Troubleshoot the cause of failure. *LSOs 3.8* Troubleshoot the corrupted PLC memory. *LSOs 3.9* Replace CPU and power supply fuses in a given PLC system.	13.	Troubleshooting of PLC system	**CO3**

LSOs 4.1 Download any open source SCADA software and install the same.
LSOs 4.2 Interpret the available components in symbol factory of SCADA software
LSOs 4.3 Create simple SCADA HMI applications and apply dynamic properties. (Select any Three from the given list)
 	
  i. Turn on and off a tube light using a Switch
  ii. Apply filling and object size properties to a rectangle, square and round object
  iii. Move the object, fill the object using slider and meter reading.
  iv. Apply orientation property to a fan and control its direction using a slider.
  v. Move a square object horizontally first, then vertically and again horizontally by applying visibility property.
LSOs 4.4 Create historical and real time trends for the given automation
	14.	Develop simple SCADA HMI applications using any one open source SCADA software and apply dynamic properties	**CO4**

LSOs 5.1 Develop a smart irrigation device to detect the change in moisture level in the soil and controls the flow of water accordingly with a DC pump. *LSOs 5.2* Build an electronic device that can remotely control home appliances with your Bluetooth-enabled smartphone and a special Android application	15.	Develop simple automation systems for the given requirement (Select any Three from the given list)	**CO5**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 5.3 Develop a PLC program to control the robot in such a way that the robot can automatically pick and place components and works in sync with the conveyor belt system. *LSOs 5.4* Develop a Automation system to Open and close the door in the shop *LSOs 5.5* Develop a line following robot with RFID sensor for supplying materials and automating workflow. *LSOs 5.6* Develop smart street light controlling mechanism which will Switch on/off the lights automatically depending on the intensity of the sunlight at that particular time of the day. *LSOs 5.7* Develop smart automated railway crossing system to detect train arrival and departure and send appropriate signals to the microcontroller.			

L) **Suggested Term Work and Self Learning (2000611F):** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.
  i.   State three advantages of using programmed PLC timer over mechanical timing relay.
  ii. It is required to have a pilot light glow, meeting all of the circuit requirements given below:
    -   All four circuit pressure Switches must be closed.
    -   At least two out of three circuit limit Switches must be closed.
    -   The reset Switch must not be closed.
  iii. Using AND, OR, and NOT gates, design a logic circuit that will solve this hypothetical problem
  iv. Prepare a comparison chart of different types of PLC
  v.   Prepare a maintenance plan for a given PLC system.

b. **Micro Projects:**
  1. Troubleshoot the faulty equipment/kit available in automation laboratory
  2. Select one industry and analyze the process and propose the automation strategies' that can be used for automation.
  3. Develop a working model of a given application using given actuators and valves.
  4. Develop a smart irrigation device to detect the change in moisture level in the soil and controls the flow of water accordingly with a DC pump.
  5. Build an electronic device that can remotely control home appliances with your Bluetooth-enabled smartphone and a special Android application
  6. Develop a PLC program to control the robot in such a way that the robot can automatically pick and place components and works in sync with the conveyor belt system.

c. **Other Activities:**
  1. Seminar Topics- PLC instructions, Timers and Counters used in a given PLC

2. Seminar Topics- Industrial Applications of PLC and SCADA, AGV, Application of automation in different area, trouble shooting of different types of PLC
3. Visits – Visit any industry with full or semi automation and prepare a report on industrial automation usedby the industry in the given section, components used, power requirement, output achieved and maintenance activities required.
4. Surveys- Carry out a market/internet survey of PLC and prepare the comparative technical specifications of any one type of PLC (Micro or Mini) of different manufacturer.
5. Product Development- Develop a prototype automatic railway crossing system
a. Software Development- Download any open source software for PLC and install on your laptop/PC and carry out basic PLC programming
6. Also download any open source software for SCADA and install on your laptop/PC and carry out basic SCADA HMI programming
7. Surveys – Carry out a internet based survey to compare SCADA and DCS

d. Self-learning topics:

- Basic concepts of working of robot
- Automated material handling.
- Instrumentation systems for inspection and testing for quality of the product
- Use of robots in different applications
- Intelligent Transportation Systems
- Communication standards and protocols used in PLC
- Use of PLC for different industrial applications
- Use of SCADA for different industrial applications
- Interfacing of PLC

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate **CO attainment**.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/Mid Sem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities *		
CO-1	10%	20%	20%	--	33%	10%	20%
CO-2	15%	25%	20%	--	33%	15%	20%
CO-3	15%	20%	20%	--	34%	15%	20%
CO-4	30%	20%	20%	50%	--	30%	20%
CO-5	30%	15%	20%	50%	--	30%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*: Other Activities include self-learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point- (O)
Note:
  ☐ The percentage given are approximate
  ☐ In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COsmapped with total experiments.
  ☐ For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Suggested Specification Table for End Semester Theory Assessment:** Specification table represents thereflection of sample representation of assessment of cognitive domain of full course.

Unit Title and Number	Total Classroom Instruction(CI) Hours	Relevant COs Number(s)	Total Marks	ETA (Marks)		
				Remember(R)	Understanding(U)	Application & above (A)
Unit-.1.0 Industrial automation Communication and Interfacing	9	**CO1**	14	5	4	5
Unit-.2.0 PLC Programming	12	**CO2**	17	5	6	6
Unit-.3.0 Installation and maintenance of PLCsystems	10	**CO3**	14	4	5	5
Unit-.4.0 SCADA and DCS	9	**CO4**	14	4	5	5
Unit-.5.0 Applications of IndustrialAutomation	8	**CO5**	11	2	4	5
Total Marks	**48**		**70**	**20**	**24**	**26**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O)   **Suggested Assessment Table for Laboratory (Practical):**

S. No.	**Laboratory Practical Titles**	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA** (%)	PDA** (%)	
1.	Transfer the control data from PLC to PC and vice versa	CO1	50	40	10
2.	Transfer the control data from PLC to PLC	CO1	50	40	10
3.	Transfer the sensor data from sensor to PLC to PLC and PC	CO1	50	40	10
4.	Interface the given PLC with a PC or a Laptop	CO1	50	40	10
5.	Identify Different parts and front panel indicators of a PLC	CO2	50	40	10
6.	Develop Ladder logic program for different arithmetic operations	CO2	50	40	10
7.	Develop Ladder logic program for different logical operations	CO2	50	40	10
8.	Program Latch and Unlatch circuit in a PLC for motor operation	CO2	50	40	10
9.	Create delay in operation using on delay, off delay and retentive timer function in a given PLC	CO2	50	40	10
10.	Count the number of objects/events using Up counter, Down counter and UP/Down counter in a PLC	CO2	50	40	10
11.	Program PLC using ladder logic to control a LED/Lamp	CO2	50	40	10
12.	Program PLC using ladder logic to control a simple traffic lightsystem	CO2	50	40	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		
			Performance		Viva-Voce (%)
			PRA** (%)	PDA** (%)	
13.	Use hygrometer to measure the humidity inside the panel	CO3	50	40	10
14.	Use thermometer to measure ambient temperature inside the panel	CO3	50	40	10
15.	Use tester to determine the voltage fluctuation at the power supply terminals is within specifications	CO3	50	40	10
16.	A given PLC is not working as per the logic instructions investigate the PLC to identify the cause of failure to show the desired output	CO3	50	40	10
17.	Investigate the cause of Noise in the given PLC	CO3	50	40	10
18.	PLC goes on blackout out by losing its operating power. Troubleshoot the cause of failure.	CO3	50	40	10
19.	Troubleshoot the corrupted PLC memory.	CO3	50	40	10
20.	Replace CPU and power supply fuses in a given PLC system	CO3	50	40	10
21.	Download any open source SCADA software and install the same.	CO4	50	40	10
22.	Interpret the available components in symbol factory in SCADA software	CO4	50	40	10

23.	Create simple SCADA HMI applications and apply dynamic properties (**Any Three**).
	  i. Turn on and off a tube light using a Switch
	  ii. Apply filling and object size properties to a rectangle, square and round object
	  iii. Move the object, fill the object using slider and meter reading.
	  iv. Apply orientation property to a fan and control its direction using a slider.
	  v. Move a square object horizontally first, then vertically and again horizontally by applying visibility property.
		CO4	50	40	10

24.	Create historical and real time trends for the given automation	CO4	50	40	10

24	**Select any three of the following: -**
	  i. Develop a smart irrigation device to detect the change in moisture level in the soil and controls the flow of water accordingly with a DC pump.
	  ii. Build an electronic device that can remotely control home appliances with your Bluetooth-enabled smartphone and a special Android application
	  iii. Develop a PLC program to control the robot in such a way that the robot can automatically pick and place components and works in sync with the conveyor belt system.
	  iv. Develop a Automation system to Open and close the door in the shop
	  v. Develop a line following robot with RFID sensor for supplying materials and automating workflow.
	  vi. Develop smart street light controlling mechanism which will Switch on/off the lights automatically depending on
		CO5	60	30	10

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA Performance PRA** (%)	PDA** (%)	Viva-Voce (%)
	the intensity of the sunlight at that particular time of theday. vii. Develop smart automated railway crossing system to detect train arrival and departure and send appropriate signals to the microcontroller.				

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Toolsand Software	Broad Specifications	Relevant Experiment/Practical Number
1.	SCADA software (reputed make like Allen Bradley, Siemensetc.,)	Ready-to-use symbol library, React and respond in real-time, Real time monitoring, Friendly, manageable, secure, extensible, Easy-to-use, easy to implement, Easy configuration, simplified maintenance, Communication with PLC, easy and flexible alarm definition, data collection and analysis for new and existing systems, easy-to-use for report generation, open access to historical data, different packages available with input/output structure. Open source software SCADA software: like Ellipse/FTVSE/Wonderware/ open SCADA can also be used	14
2.	Universal PLC TrainingSystem with HMI (Of reputed make such as Allen bradely, Siemens, etc.,) Compatible with SCADAsoftware	Human Machine Interface (HMI) display, PLC with 16 digital inputs, 16 digital outputs with RS232 communication facility. Open platform to explore wide PLC and HMI applications. Industrial look & feel. Toggle Switches, push to ON Switch, proximity sensor, visual indicator, audio indicator, and DC motor. Experiments configurable through patch board.Powerful instruction sets. Several sample ladder and HMI programs. PC based ladder and HMI programming. Extremely easy and student friendly software to develop different programs. Easy downloading of programs. Practice troubleshooting skills. Compact tabletop ergonomic design. Robust construction. PLC gateway for cloud connectivity. Open source software like Ladder logic simulator, Pico soft Simulator, Logixpro simulator, Simple EDA tools can also be used	1 to 12
3.	Safety gears	Gloves, Safety goggles, Ear protection, Dust masks andrespirators.	13
4.	Power tools	Power drills, Orbital sanders, Circular saws, Impact wrenches.	13
5.	Hand tools	Screwdrivers, Hammers, Hand saws, Hex Key Allen Wrench Set Inch and Metric, relay puller, Multi-Tool Wire Stripper/Crimper/Cutter	13

S. No.	Name of Equipment, Tools and Software	Broad Specifications	Relevant Experiment/Practical Number
6.	Electrical tools	Wire and cable strippers, Multimeters- Volts, Ohms, and Amps, Crimpers- Side Cutter Crimping, Wire Crimp Connector Kit, Digital Multimeter Clamp Meter with Amp, Volt, and Ohm, Non-Contact Voltage Tester	13
7.	Spare parts	PLC Programming Cables, SD Card Reader Compact flash, Wire Nut Set, Fuses- Class J 30, 35, 60, and 100 -amp fuses, Class CC 2, 3, 5, 10 , 15, 20, and 30 -amp fuses, 5mm x 20mm 0.032 (for 4 -20mA circuits), 0.5, 1, 2, 5, 10, and 15 amps, Cube Relays, Resistor Kit, batteries, LED Indicators PLC Processor (CPU), Input/ output module	13
8.	Thermo-hygrometer	Measuring range Temp.: -30 ... 60°C / -22 ... 140°F Measuring range rel. Humidity: 0 ... 100% rh, Measurement protocol as PDF, Data export possible as CSV, Readable without software, data sets of measured values can be stored.	13
9.	Digital Hygrometer	maximum humidity measurement- 100%RH, temperature measurement resolution -0.1egree centigrade, humidity measurement resolution -0.1%RH, minimum operating temperature - -10 to -20-degree centigrade, Maximum operating temperature +45 to +50 degree centigrade	13

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Programmable Logic Controllers	Dunning, G.	Thomson /Delmar learning, New Delhi, 2005, ISBN 13: 9781401884260
2.	Programmable Logic Controllers	Petruzella, F.D.	McGraw Hill India, New Delhi, 2010, ISBN: 9780071067386
3.	Programmable Logic Controllers	Hackworth, John; Hackworth, Federic	PHI Learning, New Delhi, 2003, ISBN: 9780130607188
4.	Industrial automation and Process control	Stenerson Jon	PHI Learning, New Delhi, 2003, ISBN:9780130618900
5.	Programmable Logic Controller	Jadhav, V. R.	Khanna publishers, New Delhi, 2017, ISBN: 9788174092281
6.	Programmable Logic Controllers and Industrial Automation - An introduction,	Mitra, Madhuchandra; Sengupta, Samarjit,	Penram International Publication, 2015, ISBN: 9788187972174
7.	Control System	Nagrath & Gopal	New Age International Pvt Ltd, ISBN:9789386070111, 9789386070111
8.	Linear Control Systems with MATLAB Applications, Publisher:	Manke, B. S.	Khanna Publishers, ISBN: 9788174093103, 9788174093103
9.	Supervisory Control and Data Acquisition	Boyar, S. A.	ISA Publication, USA, ISBN: 978-1936007097
10.	Practical SCADA for industry,	Bailey David; Wright Edwin	Newnes (an imprint of Elsevier), UK2003, ISBN:0750658053
11	Industrial Automation: Systems and Engineering	Geoffrey Williamson	States Academic Press , 2022 ISBN 9781649649270
12	Industrial Automation Technologies	Jane Taylor	States Academic Press 2023 ISBN 9781649649255
13	Introduction to Industrial Automation	Kian Pearson	Willford Press 2023, ISBN 9781682860864

(b) Online Educational Resources:

1. Software: - www.fossee.com

2. Software: - www.logixpro.com
3. Software: - www.plctutor.com
4. Software; - www.ellipse.com
5. PLC lecture: - https://www.youtube.com/watch?v=pPiXEfBO2qo
6. PLC tutorial: http://users.isr.ist.utl.pt/~jag/aulas/apil3/docs/API_I_C3_3_ST.pdf
7. https://www.youtube.com/watch?v=277wwYWolpw-PLC system troubleshooting and repair. Industrial control panel. PLC system repair.
8. https://www.youtube.com/watch?v=5Jmtvrch5Jg
9. https://www.youtube.com/watch?v=peyV9bwEaLY
10. https://www.youtube.com/watch?v=QdJhRmtKpxk&list=RDCMUCke36Li q- w5fboMHkq1APZw&index=3
11. https://www.youtube.com/watch?v=ygrrRwaJz3M

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested OER, before use by the students.

(c) Others:

1. Learning Packages
2. Users' Guide
3. Manufacturers' Manual
4. Lab Manuals

S) Course Curriculum Development Team (NITTTR, Bhopal)

☐ Dr. Vandana Somkuwar (Coordinator)
☐ Dr. C.S.Rajeshwari (Co-coordinator)

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A)	**Course Code**	: **2000605G/2000608G/2000611G**
B)	**Course Title**	: Electric Vehicle (Advanced)
C)	**Prerequisite Course(s)**	: Electric Vehicle (Basics)
D)	**Rationale**	:

The automobile manufacturing sector in India is rapidly switching over to electric vehicles used for the public as well as private transport. The Govt. of India has launched the FAME-II Scheme (Faster Adoption and Manufacturing of Hybrid & Plug-in Electric Vehicles) to encourage the progressive induction of reliable, affordable and efficient electric and hybrid vehicles and to create demand for Electric Vehicles in the country. The technology is being evolved to enhance the vehicle's efficiency and running mileage by controlling the manufacturing, maintenance and recurring costs of such vehicles. Due to the rapid increase in EV demand, industries will also require skilled manpower in this area. This advanced course on electric vehicles is included as an open elective for all the diploma programmes to provide a sound knowledge of EVs to engineering diploma students and develop skills related to testing and maintenance of various electrical, electronic and mechanical systems in EVs.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the learners' accomplishment of the following course outcomes. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the student will be able to-

CO-1 Compute various parameters affecting Vehicle movement.

CO-2 Test the operation of the different elements of the Automobile System.

CO-3 Test the battery and motor used for Power Transmission in EVs.

CO-4 Test electronic control unit system of EVs.

CO-5 Interpret the impact of Grid to Vehicle (G2V) and Vehicle to Grid (V2G) during the charging cycle.

F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes(COs)	Programme Outcomes(POs)							Programme SpecificOutcomes* (PSOs)	
	PO-1 Basic and Disciplin eSpecific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/ Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	3	-	1	2	-	-	1		
CO-2	3	2	2	3	1	-	-		
CO-3	2	2	2	3	3	1	3		
CO-4	2	3	-	2	2	-	2		
CO-5	3	2	-	2	3	1	2		

Legend: High (3), Medium (2), Low (1) and No mapping (-)
*   PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) Teaching & Learning Scheme:

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)					
			Classroom Instruction(CI)		Lab Instruction (LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+ SL)	Total Credits (C)
			L	T				
	2000605G/ 2000608G/ 2000611G	Electric Vehicle (Advanced)	03	-	04	02	09	05

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances /problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term Work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc.

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)							Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment(LA)			
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive LabAssessment (PLA)	End Laboratory Assessment (ELA)		
2000605 G/2000 608G/200 0611G		Electric Vehicle (Advanced)	30	70	20	30	20	30		200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.)

Note:

☐ Separate passing is must for progressive and end semester assessment for both theory and practical.

☐ ETA & ELA are to be carried out at the end of the term/ semester.

☐ Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done **internally (40%)** as well as **externally (60%)**. Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing:

This course curriculum detailing depicts learning outcomes at the course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (SW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to the attainment of Course Outcomes

(COs) upon the completion of the course. While curriculum detailing, NEP 2020-related reforms like

Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) andothers must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant tCOs Number(s)
TSO 1a. Explain the vehicle movement process TSO 1b. Derive various equations for the movement of Vehicles TSO 1c. Compute different resistances affecting Vehicle movement. TSO 1d. Explain the dynamics of the given type of EV system.	**Unit-1.0 Vehicle Dynamics** 1.1 Vehicle Movement 1.2 Rolling Resistance: Equation, Coefficient, factor affecting rolling resistance, typical values of rolling resistance 1.3 Grading resistance 1.4 Road resistance 1.5 Acceleration resistance 1.6 Total driving resistance 1.7 Aerodynamic drag: Equation, typicalvalues of the drag coefficient. 1.8 Vehicle dynamics • Hybrid and Electric Vehicles • DC Motor Dynamics and Control • AC Motor Dynamics and Control	**CO 1**
TSO 2 a. Identify the given elements of Automobile Systems. TSO 2 b. Describe the functions of the given elements of Automobile Systems. TSO 2 c. Explain the dynamic characteristics of the Disc Braking System for the given braking steps. TSO 2 d. Describe the Procedure for testing the given AC/DC motors. TSO 2 e. Describe the Procedure of Installation and Testingof the given EV Charging Stations. TSO 2 f. Describe the Procedure for Commissioning EV Charging Stations. TSO 2 g. Explain the functions of the EV Control Unit.	**Unit-2.0 Elements of Automobile** 2.1 Suspension and Damping systems 2.2 Brake system: Half-step braking, Full stepBraking 2.3 Transaxle 2.4 Elements of Noise Vibration andHarshness Control 2.5 Body balancing 2.6 Tyre Technology 2.7 AC/DC motor 2.8 Air-conditioning and Heating System 2.9 Lighting System 2.10 Automotive wiring system 2.11 Earthing and Insulation 2.12 Charging stations – Installation and Commissioning 2.13 Vehicle control unit	**CO 2**
TSO 3a. Compare different power transmission systems in EVs. TSO 3b. List the main Components of the EV PowerTrain. TSO 3c. Explain the functions of the given EV PowerTrain component. TSO 3d. Describe the testing procedure of the given EV Power Train component. TSO 3e. Explain the regenerative braking operation in the given EV motor. TSO 3f. Describe the speed control mechanism of the given motor. TSO 3g. Explain various parameters of the given battery. TSO 3h. Select the suitable battery for the given EV application. TSO 3i. Describe the assembling and dismantling procedure of the given battery.	**Unit-3.0 EV Power Transmission System** **3.1 Transmission System**: Single and Multi-transmission system **3.2 EV Power Train** **3.3 EV Power Train Components**: Battery Pack, DC-AC Converter, Electric Motor,On-Board Charger. **3.4 Battery Parameters**: Voltage, Current, Charging rate, efficiency, energy density, power density, State of Charge (SoC), Depth of Discharge (DoD), State of Health(SoH), Operating Temperature, specific energy, specific power, life cycle and cost. **3.5** Battery Assembly and Dismantling. **3.6** Gear and Differential Assembly **3.7** Safe disposal of used battery	**CO 3**

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 3j. Describe the Mechanism of Gear and Differential Assembly.		
TSO 4a. Describe the Vehicle Control Unit (VCU). TSO 4b. Describe the functions of the given component of the Electronic Control Unit. TSO 4c. Describe the connections of the given control unit with the EV sub-system. TSO 4d. Explain the Interaction of Controller Area Network Communication with VCU. TSO 4e. Describe the Troubleshooting and Assessment procedure of VCU.	**Unit- 4.0 Vehicle Control Unit (VCU)** 4.1 **Electronic Control Unit**: Battery Management System, DC-DC Converter, Thermal Management System and Body Control Module. 4.2 Predefined functions 4.3 Connections with EV subsystem 4.4 Controller Area Network (CAN) communication 4.5 Interaction of CAN Communication with VCU. 4.6 Troubleshooting and Assessment 4.7 Dynamometers: Introduction 4.8 Environmental Chambers	**CO 4**
TSO 5a. Explain the Classification of Charging Technologies. TSO 5b. Explain the impact of the Grid on Vehicle Charging and Vehicle Charging on the Grid. TSO 5c. Describe the testing procedure of the given Bi-directional charging systems. TSO 5d. Explain the Energy Management Strategies in the EV. TSO 5e. Explain the Wireless Power Transfer (WPT) technique for EV Charging.	**Unit- 5.0 EV Charging Technologies** 5.1 Charging Technology: Classification 5.2 Grid-to-Vehicle (G2V) 5.3 Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home(V2H). 5.4 Bi-directional EV Charging Systems. 5.5 Energy Management Strategies. 5.6 Wireless Power Transfer (WPT) technique for EV Charging.	**CO 5**

Note: One major TSO may require more than one theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical (2000608G):

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSO 2.1 Test the operation of the Control Disc Braking system and control the regenerative braking system using a test rig. LSO 2.2 Test the performance (Speed v/s Braking Torque) of the Disc Braking System in Half step and Full step braking modes.	1.	• Testing of Control Disc Braking system and Control Regenerative Braking system.	**CO2**
LSO 2.3 Test the performance of different types of propulsion motors.	2.	• Testing of Motors	
LSO 2.4 Test the continuity of the automotive wiring system in the EV	3.	• Testing of the automotive wiring system.	
LSO 3.1 Test the performance of a new set of batteries and aged batteries. LSO 3.2 Compare the performance of the battery and find the Fuel Gauge after discharging the battery. a. 0% - 100% b. 30% - 100% c. 50% - 100% LSO Evaluate the following parameters of the	4.	• Testing of Batteries used in EVs	**CO2, CO3**

3.3				
	given EV battery. a. Specific power b. Specific energy			

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
c. Life span and d. Cost parameters LSO 3.4 Evaluate the State of Health (SoH) of the given EV Battery after several charge/discharge cycles.			

LSO 3.5 Test the dynamic performance of the given motor;
  a) Speed and torque spectrum.
  b) Speed and torque oscillation
  c) Friction torque friction spectrum.
 	
LSO 3.6 Test the following speed-controlled performance characteristics of the given motor;
  a. Motor voltage over time
  b. Motor current over time.
  c. Speed and torque over time.
  d. Torque over speed.
  e. Current over speed.
  f. Electrical input power and the mechanical input power over speed
	5.	• Speed control of Electrical Motors	

LSO 4.1 Connect the components of the EC Units with EV subsystems. LSO 4.2 Troubleshoot basic faults in the electronic control unit of EV.	6.	• Connection of Electronic Control Unitcomponents • Troubleshooting of electronic control unit	**CO4**
LSO 5.1 Evaluate the impact of the Grid on VehicleCharging and Vehicle Charging on the Grid.	7.	• Impacts of G2V and V2G	**CO 5**
LSO 5.2 Prepare a layout of a charging station	8.	• Demonstration of Charging stations	

L) **Suggested Term Work and Self-Learning (2000611G)**: Some sample suggested assignments, micro projectsand other activities are mentioned here for reference.

  a. **Assignments**: Questions/ Problems/ Numerical/ Exercises to be provided by the course teacher in line with the targeted COs.

  b. Micro Projects:
    1. Design and build a physical model of an EV motor and powertrain components from scratch.
    2. Build and simulate communication systems of EVs using some software tools.
    3. Prepare a report on "the way carbon credit works and companies utilize it to reduce their emission values".
    4. Develop an EV prototype power train using locally procured hardware components.

  c. Other Activities:
    1. **Seminar Topics**:
        • Safe disposal process of Used Batteries.
        • Charging Technologies used for charging the EV.
        • EV power transmission systems.
    2. **Surveys** – Visit an electric vehicle manufacturing plant and prepare report on HVAC system used in EV.

3. Self-learning topics:

- Impact of fleet charging of EVs on Power Systems.
- Energy Management in EV.
- Fuel Cell powered bus.
- EV Battery disposal and recycling.
- Mobility and connectors.

M) **Suggested Course Evaluation Matrix:** The course teacher has to decide and use the appropriate assessment strategy and its weightage, in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of the student in each of these designed activities is to be used to calculate **CO attainment.**

COs	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/MidSem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities*		
CO-1	20%	15%	20%	--	--	--	--
CO-2	20%	20%	20%	--	--	35%	25%
CO-3	20%	30%	20%	70%	40%	40%	25%
CO-4	20%	25%	20%	30%	20%	10%	25%
CO-5	20%	10%	20%	--	40%	15%	25%
Total Marks	**30**	**70**	**20**	**20**	**10**	**20**	**30**
			50				

Legend:

*: Other Activities include self- learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point- (O)

Note:

- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COsmapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) **Suggested Specification Table for End Semester Theory Assessment:** Specification table represents thereflection of sample representation of assessment of the cognitive domain of the full course.

Unit Title and Number	Total Classroom Instruction(CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember(R)	Understanding(U)	Application& above (A)
Unit-1.0 Vehicle Dynamics	8	**CO1**	12	4	5	3
Unit-2.0 Elements of Automobile.	10	**CO2**	15	5	6	4
Unit-3.0 EV Power Transmission System.	14	**CO3**	20	4	10	6
Unit-4.0 Vehicle Control Unit (VCU)	10	**CO4**	15	4	6	5
Unit-5.0 Charging Technologies	6	**CO5**	8	3	3	2
Total Marks	**48**		**70**	**20**	**30**	**20**

Note: Similar table can also be used to design class/mid-term/ internal question papers for progressive assessment.

O) **Suggested Assessment Table for Laboratory (Practical):**

S. N.	Laboratory Practical Titles	Relevant COs Number(s)	PLA /ELA		
			Performance		Viva-Voce (%)
			PRA** (%)	PDA** (%)	
1	Testing of Control Disc Braking system and ControlRegenerative Braking system.	CO2	60	30	10
2	Testing of Motors.				
3.	Testing of automotive wiring system.				
4.	Testing of Batteries used in EVs	CO2, CO3	60	30	10
5.	Speed control of Electrical Motors		60	30	10
6.	Connection of Electronic Control Unit components	CO4	60	30	10
7.	Troubleshooting of electronic control unit				
7	Impacts of G2V and V2G	CO 5	30	60	10
8	Demonstration of Charging stations		70	20	10

Legend:
PRA*: Process Assessment
PDA**: Product
Assessment

Note: This table can be used for both the end semester as well as progressive assessment of practicals. Rubrics need to be prepared by the course teacher for each experiment/practical to assess the student's performance.

P) **Suggested Instructional/Implementation Strategies:** Different Instructional/ Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources (OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S. No.	Name of Equipment, Tools andSoftware	Broad Specifications	Relevant Experiment/Practical Number
1.	Disc Braking and Regenerativebraking system test rig	Test rig equipment for Demonstration of Disc Brakingand Regenerative Braking system operation.	1
2.	Disc Braking System	Test rig / Software for testing the performance of the disc braking system in Half step and Full step braking mode.	1
3.	Induction motor	Induction motor For EV applications with testing kit	2,5
4.	Switched reluctance motor	Switched reluctance motor for EV applications with testing kit	2,5

5.	Permanent magnet (PM) DC motors	Permanent magnet (PM) DC motors for EV applications with testing kit	2,5
6.	Automotive wiring system	Testing facility of automotive wiring system using software /actual EV systems	3

S. No.	Name of Equipment, Tools andSoftware	Broad Specifications	Relevant Experiment/Practical Number
7.	Lithium Ion and Lead-acid Batteries	12V, 7Ah with testing setup.	4
8.	Nickel-based batteries (metal hydride and cadmium battery).	12V, 7Ah with testing setup.	4
9.	Battery tester	For testing battery parameters	4
10.	Battery charger	Battery charger for EV	4
11.	Battery Management System	Training kit or simulation for BMS	4
12.	DC-DC Converter	48V to 12V bidirectional DC-DC Converter	4
13.	Power Analyser	To observe the impacts of G2V and V2G	5
14.	BMS setup	For Demonstration & training	4
15.	DC power supply	0-32V	5
16.	Charging Station Simulator	For Demonstration & training purposes.	5
17.	EC Unit with EV subsystems	Electronic Control Unit Hardware parts/ software for demonstrating the Connection of Electronic Control Unit components with EV subsystems.	6,7
18.	Facility to demonstrate the impact of the Grid on Vehicle Charging and Vehicle Charging on the Grid.	-	7

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Electric Vehicles: And the End of the ICE age	Anupam Singh	Kindle Edition ASIN: B07R3WFR28
2.	Wireless Power Transfer Technologies for ElectricVehicles (Key Technologies on New Energy Vehicles)	Xi Zhang, Chong Zhu,Haitao Song	Springer Verlag, Singapore; 1st ed.2022 edition (23 January 2022) ISBN-13: 978-9811683473
3.	Modern Electric, Hybrid Electric, and Fuel Cell Vehicles	EHSANI	CRC Press; Third edition (1 January2019) ISBN-13: 978-0367137465
4.	Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles	John G. Hayes, G. AbasGoodarzi	Wiley; 1st edition (26 January 2018) ISBN-13: 978-1119063643
5.	New Perspectives on Electric Vehicles	Marian Găiceanu (Editor)	IntechOpen (30 March 2022) ISBN-13: 978-1839696145
6.	Electric and Hybrid Vehicles,	Tom Denton, Taylor &Francis	2nd Edition (2020) ISBN- 9780429296109
7.	Hybrid Electric Vehicles: Energy Management Strategies	S. Onori, L. Serrao and G.Rizzoni	Springer (2016) ISBN: 978-1-4471-6781-5

8.	Electric & Hybrid Vehicles	A.K. Babu	Khanna Publishing House, NewDelhi, 1st Edition (2018) ISBN: 9789386173713, 9386173719

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
9.	Power Electronics: Circuits, Devices and Applications,	Rashid, M. H.	Pearson, 3rd edition, (2013) ASIN: B07HB3BM1W
10	Electric Vehicle Engineering	Liana Walker	Clanrye International2023, ISBN-978164729097
11	Electric Vehicles: Current Progress & Technologies	Vanessa Jones	Murphy & Moore Publishing 2023, ISBN 9781649872746
12	20 Electric and Hybrid Vehicles: Principles, Design and Technology	Mary Murphy	Larsen and Keller Education 2023 ISBN 9781641728520

(b) Online Educational Resources:

1. https://www.energy.gov/eere/fuelcells/fuel-cell-systems
2. https://powermin.gov.in/en/content/electric-vehicle
3. https://www.iea.org/reports/electric-vehicles
4. https://www.oercommons.org/search?f.search=Electric+Vehicles
5. https://fame2.heavyindustries.gov.in/Index.aspx

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

(c) Others:

1. Learning Packages on EV
2. EV Users' Guide
3. EV Manufacturers' Manual
4. EV Lab Manuals

S) Course Curriculum Development Team (NITTTR, Bhopal)

☐ Dr. A. S. Walkey (Coordinator)
☐ Dr. S. S. Kedar (Co- coordinator)

******

A)	**Course Code**		: **2000605H/2000608H/2000611H**		
B)	**Course Title**		: Robotics (Advance)		
C)	**Pre- requisite Course(s)**		: Robotics (Basic)		
D)	**Rationale**		:		

Efficiency and quality are the demands of industry 4.0. Robotics is a constituent of Industry 4.0 which not only provides the former two but also is beneficial for hazardous and similar challenging situations. The use of robotic technology is developing at a very fast rate in all types of industries whether manufacturing, service or tertiary. Engineers should be competent to use the robotic technology for industry and society advantage. This course aims for the diploma engineers to have advanced skills in robotic applications and use in digital manufacturing.

E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course outcomes by the learners. For this, the learners are expected to perform various activities related to three learning domains (Cognitive, Psychomotor and Affective) in classroom/ laboratory/ workshop/ field/ industry.

After completion of the course, the students will be able

to-CO-1   Plan the use of robots in engineering

applications.

CO-2 Elucidate the conceptual place of the robotic components for engineering processes.

CO-3 Use robots for small automatic robotic applications.

CO-4 Compute the economics associated with use of robots in industries.

CO-5 Select appropriate robot for industrial requirements and other applications.

F) **Suggested Course Articulation Matrix (CAM):**

Course Outcomes(COs)	Programme Outcomes(POs)							Programme Specific Outcomes* (PSOs)	
	PO-1 Basic and Discipline Specific Knowledge	**PO-2** Problem Analysis	**PO-3** Design/Development of Solutions	**PO-4** Engineering Tools	**PO-5** Engineering Practices for Society, Sustainability and Environment	**PO-6** Project Management	**PO-7** Life Long Learning	**PSO-1**	**PSO-2**
CO-1	-	-	3	-	2	-	2		
CO-2	-	2	3	2	-	-	-		
CO-3	3	2	3	-	-	-	2		
CO-4	3	-	-	2	-	-	-		
CO-5	3	2	-	-	2	-	-		

Legend: High (3), Medium (2), Low (1) and No mapping (-)
*   PSOs will be developed by respective programme coordinator at institute level. As per latest NBA guidelines, formulating PSOs is optional

G) **Teaching & Learning Scheme:**

Board of Study	Course Code	Course Title	Scheme of Study (Hours/Week)				
			Classroom Instruction (CI)		Lab Instruction(LI)	Notional Hours (TW+ SL)	Total Hours (CI+LI+TW+ SL)	Total Credits (C)
			L	**T**				
	2000605H	Robotics	03	-	04	02	09	05

	/2000608H /2000611H	(Advance)						

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e. Lecture (L), Tutorial (T), Case method, Demonstrations, Video demonstration, Problem based learning etc. to deliver theoretical concepts)

LI: Laboratory Instruction (Includes experiments/practical performances/ problem-based experiences in laboratory, workshop, field or other locations using different instructional/Implementation strategies)

Notional Hours: Hours of engagement by learners, other than the contact hours for ensuring learning.

TW: Term work (includes assignments, seminars, micro projects, industrial visits, any other student activities etc.)

SL: Self Learning, MOOCs, spoken tutorials, online educational resources etc

C: Credits = (1 x CI hours) + (0.5 x LI hours) + (0.5 x Notional hours)

Note: TW and SL have to be planned by the teacher and performed by the learner under the continuous guidance and feedback of teacher to ensure outcome of learning.

H) Assessment Scheme:

Board of Study	Course Code	Course Title	Assessment Scheme (Marks)							Total Marks (TA+TWA+LA)
			Theory Assessment (TA)		Term Work & Self-Learning Assessment (TWA)		Lab Assessment(LA)			
			Progressive Theory Assessment (PTA)	End Theory Assessment (ETA)	Internal	External	Progressive eLab Assessment (PLA)	End Laboratory Assessment		
	2000605H /2000608H /2000611H	Robotics (Advance)	30	70	20	30	20	30		200

Legend:

PTA: Progressive Theory Assessment in class room (includes class test, mid-term test and quiz using online/offline modes)

PLA: Progressive Laboratory Assessment (includes process and product assessment using rating Scales and rubrics)

TWA: Term work & Self Learning Assessment (Includes assessment related to student performance in assignments, seminars, micro projects, industrial visits, self-learning, any other student activities etc.

Note:

- Separate passing is must for progressive and end semester assessment for both theory and practical.
- ETA & ELA are to be carried out at the end of the term/ semester.
- Term Work is to be done by the students under the guidance of internal faculty but its assessment will be done internally (40%) as well as externally (60%). Assessment related to planning and execution of Term Work activities like assignment, micro project, seminar and self-learning is to be done by internal faculty (Internal Assessment) whereas assessment of output/product/ presentation related to these activities will be carried out by external faculty/expert (External Assessment). However, criteria of internal as well as external assessment may vary as per the requirement of respective course. For valid and reliable assessment, the internal faculty should prepare checklist & rubrics for these activities.

I) Course Curriculum Detailing: This course curriculum detailing depicts learning outcomes at course level and session level and their attainment by the students through Classroom Instruction (CI), Laboratory Instruction (LI), Term Work (TW) and Self Learning (SL). Students are expected to demonstrate the attainment of Theory Session Outcomes (TSOs) and Lab Session Outcomes (LSOs) leading to attainment of Course Outcomes (COs) upon the completion of the course. While curriculum detailing, NEP 2020 related reforms like Green skills, Sustainability, Multidisciplinary aspects, Society connect, Indian Knowledge System (IKS) and others must be integrated appropriately.

J) Theory Session Outcomes (TSOs) and Units:

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 1a. Define the need and scope of industrial robots. TSO 1b. Describe the concept of robot dynamics with regards to methods for orientation and location of objects. TSO 1c. Analyse robot direct kinematics for the given 2 DOF planar manipulator. TSO 1d. List types of robots TSO 1e. List safety steps while handling the given robot.	**Unit-1.0 Robot Kinematics, Dynamics and Industrial Applications** 1.1 Definition need and scope of Industrial robots 1.2 Robot dynamics – Methods for orientation and location of objects 1.3 Planar Robot Kinematics – Direct and inversekinematics for 2 Degrees of Freedom. 1.4 Safety while operating and handling robot	CO2, CO3
TSO 1f. Interface robots with the given welding machine. TSO 1g. Interface robots with the given painting machine. TSO 1h. Interface robots with the given assembly machine.	1.5 Robot Industrial applications: • Welding Robots-Welding Guns, Welding Electrodes, Welding Power Sources, shielding gases, Robot interfacing • Spray painting Robots, assembly operation, cleaning.	
TSO 2a. Explain the techniques to control robot motion. TSO 2b. Describe the given robot drive system.TSO 2c. Describe the types of grippers. TSO 2d. Design grippers for specificapplication. TSO 2e. Test the designed gripper for the application. TSO 2f. Use Bar code technology for robotic applications. TSO 2g. Integrate radio frequency identification technology in robotic applications. TSO 2h. Assemble an automated guided vehicle for the given situation using standard components. TSO 2i. Assemble a simple automated storage and retrieval systems (ASRS) for the given situation using standard components.	**Unit– 2.0 Robot Drives, Control and Material Handling** 2.1 Controlling the Robot motion. 2.2 Position and velocity sensing devices. 2.3 Drive systems – Hydraulic and Pneumaticdrives 2.4 Linear and rotary actuators and control valves 2.5 Electro hydraulic servo valves, electric drives,motors 2.6 End effectors – Vacuum, magnetic and air operated grippers 2.7 Material Handling; automated guided vehicle systems, automated storage and retrieval systems (ASRS) 2.8 Bar code technology 2.9 Radio frequency identification technology.	CO2, CO3
TSO 3a. Differentiate between various work cell layouts. TSO 3b. Select work cell for specific robot withjustification. TSO 3c. Analyse robot cycle time. TSO 3d. Explain industrial applications of roboticcell. TSO 3e. Follow safety procedures in robotic cell.	**Unit– 3.0 Robot Cell Design and Application** 3.1 Robot work cell design, control and safety 3.2 Robot cell layouts 3.3 Multiple Robots and machine interference 3.4 Robot cycle time analysis 3.5 Industrial application of robotic cells	CO3
TSO 4a. List different programming languages for the robots TSO 4b. Describe artificial intelligence TSO 4c. Write a programme in the required language to operate a robot for the given task. TSO 4d. Optimise robot programming parameters.	**Unit– 4.0 Robot Programming and Economics of Robotization** 4.1 Characteristics of task level languages through programming methods 4.2 Motion interpolation 4.3 Artificial intelligence: Goals of artificialintelligence, AI techniques, problem	CO1, CO4, CO5

Major Theory Session Outcomes (TSOs)	Units	Relevant COs Number(s)
TSO 4e. Select a robot on the basis of cycle time analysis. TSO 4f. Conduct an economic analysis for use of robots. TSO 4g. Follow testing methods and acceptance rules for industrial robots.	representation in AI 4.4 Problem reduction and solution techniques. 4.5 Application of AI and KBES in Robots 4.6 Selection of Robots; Factors influencing the choice of a robot, selection of robot components, robot performance testing, work cycle time analysis 4.7 Economics analysis for robotics, costdata required for the analysis 4.8 Methods of economic analysis; Pay back method, equivalent uniform annual cost method, return on investment method. 4.9 Testing methods and acceptance rules for industrial robots	
TSO 5a. Describe applications of robots in healthcare and medicine. TSO 5b. Describe applications of robots in Construction industry. TSO 5c. Describe applications of robots in Underground coal mining. TSO 5d. Describe applications of robots in uutilities, military & firefighting operations. TSO 5e. Describe applications of robots in undersea and space TSO 5f. Describe applications of robots in brief in logistics, retail and hospitality, and smart cities. TSO 5g. Describe applications of robots in farming and agriculture in brief explain in brief the use of microrobots, nano robots, soft robots, humanoid robots	**Unit–5.0 Applications in Non-manufacturing Environments** 5.1 Applications of Robots in • Healthcare and medicine • Construction industry • Underground coal mines • Utilities, military & firefightingoperations • Undersea • Space • Logistics, • Retail and Hospitality • Smart Cities • Farming and Agriculture 5.2 Overview of Microrobots, nano robots, soft robots, humanoid robots	**CO5**

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical (2000608H):

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 1.1 Identify Wireless Sensor Network. LSOs 2.1 LSOs 1.2 Use wireless sensor Network for different robotic applications	1.	Identify different wireless sensor network in robotics viz. ZigBee, LoRa.	**CO1, CO3**
LSOs 2.2 Identify different Radio Frequency (RF)Controlled Wireless LSOs 2.2 Use Radio Frequency (RF) Controlled Wireless for different robotic applications.	2.	Use different Radio Frequency (RF) ControlledWireless Robots.	**CO1, CO2**
LSOs 3.1 Identify the different Voice operated robot with speaker identification technology	3.	Examine different voice operated robot with speaker identification technology.	**CO1, CO3**

Practical/Lab Session Outcomes (LSOs)	S. No.	Laboratory Experiment/Practical Titles	Relevant COs Number(s)
LSOs 3.2 Use different Voice operated robot with speaker identification technology for different robotic applications.			
LSOs 5.1 Identify the components required for a computer-controlled pick and place robot (wireless). LSOs 5.2 Integrate the components for the required application.	4.	Design a computer-controlled pick and place robot (wireless)	**CO1**
LSOs 6.1 Identify the components required for a Zigbee controlled Boat with wireless video and voice transmission. LSOs 6.2 Integrate the components for the required application.	5.	Design a Zigbee controlled Boat with wireless video and voice transmission.	**CO2, CO3**
LSOs 8.1 Identify the components required for a PC controlled wireless Multipurpose robot for engineering applications. LSOs 8.2 Integrate the components for the required application.	6.	Design a PC controlled wireless Multipurpose robot for simple engineering applications.	**CO2, CO4, CO5**
LSOs 9.1 Identify the components required for an unmanned arial photography LSOs 9.2 Integrate the components for the required application.	7.	Design an unmanned arial photography system.	**CO3, CO5**
LSOs 10.1 Develop a program LSOs 10.2 Simulate palletizing and depalletizing operations through robots.	8.	Develop program for real time (online TPP) Palletizing and Depalletizing operations through robots.	**CO5**
LSOs 11.1 Develop a program LSOs 11.2 Simulate direction control and step control logic for robotization	9.	Develop TPP / Offline program for vision-based inspection for robots.	**CO4, CO5**
LSOs 12.1 Develop a program LSOs 12.2 Simulate robotising an inspection and part assembly.	10.	Program and simulate coordinated identification, inspection and part assembly for robots.	**CO1, CO5**
LSOs 13.1 Develop a program. LSOs 13.2 Simulate obstacle avoidance of robots.	11.	Develop obstacle avoidance robot Programming	**CO1, CO5**
LSOs 14.1 PLC programming. LSOs 14.2 Simulate robotising of welding operation.	12.	Program and simulate welding operation using robot simulation software.	**CO1, CO5**
LSOs 15.1 Simulate robotising of drilling operation.	13.	TPP / Offline program for drilling operation.	**CO1, CO5**
LSOs 16.1 Develop a program for an industrial application. LSOs 16.2 Execute the robot programme.	14.	Program to execute an industrial robot application using a given configuration.	**CO1, CO5**
LSOs 17.1 Use robot simulation software for Direct Kinematic analysis upto 4-axis robots LSOs 17.2 Correlate the simulated results with respective mathematical calculations.	15.	Analyse Direct Kinematics of 4-axis robot using available software.	**CO2**

L) **Suggested Term Work and Self Learning (2000611H):** Some sample suggested assignments, micro project and other activities are mentioned here for reference.

   a. **Assignments**: Questions/Problems/Numerical/Exercises to be provided by the course teacher in line with the targeted COs.

   b. **Micro Projects:** A suggestive list of micro-projects is given here. Similar micro-projects that match the COs could be added by the concerned course teacher. The student should strive to

identify eco-friendly or recycled material prior to selection for robotic applications.

1. Develop coin separating robot.
2. Develop robot using radio frequency sensors for material handling.
3. Develop robot for land mine detection.
4. Develop a robot for car washing.

   c. Other Activities:
   1. Seminar Topics: Recent developments in the industrial applications of robotics
   2. Visits: Visit a robotic exhibition.
   3. Case Study: Identify a robotic application in automobiles and present a case study
   4. Download videos related to simple robotic applications in domestic and industrial purposes.
   5. Self-learning topics:
      - Robotic component manufacturers

M) Suggested Course Evaluation Matrix: The course teacher has to decide and use appropriate assessment strategy and its weightage in theory, laboratory and Term Work for ensuring CO attainment. The response/performance of each student in each of these designed activities is to be used to calculate CO attainment.

COs	Course Evaluation Matrix						
	Theory Assessment (TA)**		Term Work Assessment (TWA)			Lab Assessment (LA)#	
	Progressive Theory Assessment (PTA) Class/MidSem Test	End Theory Assessment (ETA)	Term Work & Self-Learning Assessment			Progressive Lab Assessment (PLA)	End Laboratory Assessment (ELA)
			Assignments	Micro Projects	Other Activities *		
CO-1	25%	23%	20%	10%	25%	10%	20%
CO-2	20 %	23%	20%	10%	25%	20%	20%
CO-3	15%	17%	20%	25%	25%	20%	20%
CO-4	20%	20%	20%	15%	25%	20%	20%
CO-5	20%	17%	20%	40%	--	30%	20%
Total Marks	30	70	20	20	10	20	30
			50				

Legend:
*: Other Activities include self-learning, seminar, visits, surveys, product development, software development etc.
**: Mentioned under point- (N)
#: Mentioned under point-(O)
Note:
- The percentage given are approximate
- In case of Micro Projects and End Laboratory Assessment (ELA), the achieved marks will be equally divided in all those COs mapped with total experiments.
- For CO attainment calculation indirect assessment tools like course exit survey need to be used which comprises of questions related to achievement of each COs.

N) Suggested Specification Table for End Semester Theory Assessment: Specification table represents the reflection of sample representation of assessment of cognitive domain of full course.

Unit Number and Title	Total Classroom Instruction(CI) Hours	Relevant COs Number (s)	Total Marks	ETA (Marks)		
				Remember (R)	Understanding(U)	Application & above (A)
Unit-1.0 Robot Kinematics, Dynamics and Industrial Applications	12	**CO2, CO3**	16	6	5	5
Unit– 2.0 Robot Drives, Control and Material Handling	10	**CO2, CO3**	16	4	8	4

Unit– 3.0 Robot Cell Design and Application	8	**CO3**	12	2	4	6
Unit– 4.0 Robot Programming and Economics of Robotization	10	**CO1, CO4, CO5**	14	4	4	6
Unit– 5.0 Applications in Non-manufacturing Environments	8	**CO5**	12	4	4	4
Total Marks	**48**		**70**	**20**	**25**	**25**

Note: Similar table can also be used to design class/mid-term/ internal question paper for progressive assessment.

O) Suggested Assessment Table for Laboratory (Practical):

S. No.	Laboratory Practical Titles	Relevant COs Number(s)	PLA/ELA		Viva-Voce (%)
			Performance		
			PRA** (%)	PDA** (%)	
1.	Identify different wireless sensor network in robotics viz. ZigBee, LoRa.	CO1, CO3	40	40	20
2.	Use different Radio Frequency (RF) Controlled Wireless Robots.	CO1, CO2	40	40	20
3.	Examine different voice operated robot with speaker identification technology.	CO1, CO3	40	40	20
4.	Design a computer-controlled pick and place robot (wireless)	CO1, CO4	40	40	20
5.	Design a Zigbee controlled Boat with wireless video and voice transmission.	CO2, CO3	40	40	20
6.	Design a PC controlled wireless Multipurpose robot for simple engineering applications.	CO3, CO4	40	40	20
7.	Design an unmanned arial photography system.	CO3, CO5	40	40	20
8.	Develop program for real time (online TPP) Palletizing and Depalletizing operations through robots.	CO5	40	40	20
9.	Develop TPP / Offline program for vision-based inspection forrobots.	CO4, CO5	40	40	20
10.	Program and simulate coordinated identification, inspection and part assembly for robots.	CO1, CO5	40	40	20
11.	Develop Obstacle avoidance robot Programming	CO1, CO5	40	40	20
12.	Program and simulate welding operation using robot simulation software.	CO1, CO5	40	40	20
13.	TPP / Offline program for drilling operation.	CO1, CO5	40	40	20
14.	Program to execute an industrial robot application using a given configuration.	CO1, CO5	40	40	20
15.	Analyse Direct Kinematics of 4-axis robot using availablesoftware.	CO2, CO3	40	40	20

Legend:
PRA*: Process Assessment
PDA**: Product Assessment

Note: This table can be used for both end semester as well as progressive assessment of practical. Rubrics need to be

prepared by the course teacher for each experiment/practical to assess the student performance.

P) **Suggested Instructional/Implementation Strategies:** Different Instructional/Implementation Strategies may be appropriately selected, as per the requirement of the content/outcome. Some of them are Improved Lecture, Tutorial, Case Method, Group Discussion, Industrial visits, Industrial Training, Portfolio Based Learning, Role Play, Live Demonstrations in Classrooms, Lab, Field, Information and Communications Technology (ICT) Based Teaching Learning, Blended or flipped mode, Brainstorming, Expert Sessions, Video Clippings, Use of Open Educational Resources(OER), MOOCs etc.

Q) **List of Major Laboratory Equipment, Tools and Software:**

S.No.	Name of Equipment,Tools and Software	Broad Specifications	Relevant Experiment /Practical Number
1.	6 Axis Articulated Robot(Material Handling)- 1 No	- Articulated Type - Controlled axis: 6-axes (J1, J2, J3, J4, J5, J6) - Reach: 717 mm - Installation Floor, Upside-down (Angle mount) - Motion range (Maximum Speed) - J1 Axis Rotation7.85 rad/s - J2 Axis Rotation 6.63 rad/s - J3 Axis Rotation 9.08 rad/s - J4 Axis Rotation 9.60 rad/s - J5 Axis Rotation 9.51 rad/s - J6 Axis Rotation 17.45ras/s - Max. load capacity Wrist: 4Kg - Allowable Load moment 16.6 N-m at wrist J4 Axis, J5Axis, J6 Axis - Allowable Load inertia).47 kg-m^2 at wrist J4 Axis J5Axis, J6 Axis - Repeatability: +/- 0.05mm - Mass: 21 Kg Minimum - Installation environment: Ambient temperature: 0 – 45°C - Ambient humidity: Normally 75%RH or less. No dew,nor frost allowed. - Vibration Acceleration: 4.9 m/s2 (0.5G or less)	1, 2, 3, 12
2.	6 Axis Articulated Robot(General Purpose-Welding, Assembly, Drilling) - 1 No	Link 1: 300 mm Link 2: 300 mm Joint actuator: DC Stepper Motor Transmission: Timing Belt Drive Position feedback: Proximity Switch Gripper actuator: Pneumatic Weight of robot: 50 Kg. Accuracy: ±0.3 Repeatability: ±0.2Tip Velocity range: 500 mm / minPay load capacity: 2 kg (including griper) J1 - Waist: ± 140°J2 - Shoulder: -100 - 60°J3 - Elbow: - 70 + 10°J4 - Wrist rotate: ± 70°J5 - Wrist pitch: ± 35°J6 - Wrist roll: ± 180°External I/O8 Programmable digital inputs8 Programmable digitaloutputs	8, 9, 14
3.	A mounted vision system with software (Free open source Robot simulation software)	Integrity Serial Bus System, CAN to Build Intelligent Device Network, Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor, movable Omni Wheel of Omni-Directional, Actuator operation control by DC Encoder Motor, DC-Motor control and operation by Accelerometer, Gyro, Ultrasonic and PSD sensor, Androx Studio; brushless ILM 70×10 Robo Drive DC motor; sensor-actuator units of ARMAR-4; SD-25-160-2A-GR-BB	3, 4, 5, 11

S.No.	Name of Equipment,Tools and Software	Broad Specifications	Relevant Experiment /Practical Number
		Harmonic Drive reduction gear unit high gear ratio of 160: 1; structural parts (white) are made out of high-strength aluminum, Hollow shaft with strain gauges for torque sensing, motor's magnetic incremental encoder (AMS5306), digital buses (SPI or 12C); Motor interface PCB includes a 13-Bit temperature-to-digital converter with a temperature range from −40°C to 125°C (Analog Devices ADT7302)	
4.	6-axis Robotics Trainer	Programmable robotic arm with an interactive frontpanel. Software to demonstrates functioning of the trainer as well as allows a user to develop their own programs. NV330; 8 bit microcontroller to ARM processors; Record and Play capability; Optional interfacing with PLC; Touch operated ON/OFF Switch; Auto set to home position; Applications can be developed;Data acquisition using USB	3, 4, 5, 13
5.	E-Yantra Firebird kit	• Fire Bird V 2560 Robot • Spark V Robot • Fire Bird V P89V51RD2 adapter card • Fire Bird V LPC2148 adapter card • LSM303 3 axis digital accelerometer and 3 axes magnetometers • L3G4200 3 axis digital gyroscope • Gyroscope, accelerometer and GPS interfacing module for the robot • GPS receiver • Zigbee Modules 100m range • Zigbee Modules Adapter • Metal-gear Servo Motors • Servo Motor Based Gripper kit for the Fire Bird Vrobot • Sharp infrared range sensor (10cm to 500cm) • Arduino Uno/Nano • Hexapod • 16 Programming Software (AVR studio, Keil, AVR Boot loader, Flash Magic)	1, 3, 5, 6, 7, 10
6.	Robot simulator for Robotics	Educational networking licensed Robotic system with simulation software	2, 8, 10
7.	Assorted sensors	Optical encoders, Acoustic sensors ,IR, Potentiometer, RTD, Thermistor, strain gauge, piezoelectric, etc.	4
8.	Vision equipment	Camera, Imaging Components: Point, Line, Planar and Volume Sensors	1, 4, 10
9.	Raspberry Pi kit	1.2GHz quad-core Broadcom BCM2837 CPU with 1GB DDR2 RAM with in-built Wi-Fi & Bluetooth Video Core IV 3D graphics core 40 pin extended pins - with 27 GPIO pins Micro SD slot Multiple ports: Four USB ports, full sized HDMI, four pole stereo output and composite video port, CSI camera port and DSI display port 10/100 BaseT Ethernet Micro-USB, power source 5V, 2A	7, 9

R) Suggested Learning Resources:

(a) Books:

S. No.	Titles	Author(s)	Publisher and Edition with ISBN
1.	Introduction to Robotics Mechanics and Control	John Craig	Pearson Education 978-9356062191
2.	Robotics and controls	Mittal R.K., Nagrath I.J.	Tata McGraw Hill Education Pvt. Ltd.;2017; **978**-0070482937
3.	Robotics and Image Processing: AnIntroduction	Janaki Raman. P. A	Tata McGraw Hill Publishing companyLtd., 1998; 978-0074621677
4.	Industrial Robotics - Technology,Programming and Applications	Nicholas Odrey, Mitchell Weiss, Mikell Groover Roger Nagel, AshishDutta	McGraw Hill Education; 2nd Edition;978 -1259006210
5.	Robotic Engineering: an integrated approach	Richard D. Klafter, Thomas A. Thomas A. Chmielewski, Michael Negin	Prentice Hall of India, N. Delhi, 2009;978-8120308428
6.	Industrial Robotics Technology,Programming and Applications	Mikell P. Groover, Mitchell Weiss,Roger N. Nagel, Nicholas G. Odrey	McGraw-Hill Education, SecondEdition, 978-1259006210
7.	Robotics	Appuu Kuttan K. K.	Dreamtech Press, First Edition, 2020, 978-9389583281
8.	Introduction to Robotics: Analysis,Control, Applications	Saeed B. Niku	Wiley; Second Edition,978-8126533121
9.	Essentials of Robotics ProcessAutomation	S. Mukherjee	Khanna Publication, First Edition, 978-9386173751
10.	Robotics	R R Ghorpade, M M Bhoomkar	Nirali Prakashan 978-9388897020
11.	Mechatronics: Engineering Fundamentals	Allie Weaver	Murphy & Moore Publishing 2022 ISBN 9781649872758
12.	Elements of Robotics	Greg Scott	States Academic Press 2022 ISBN 9781649649261
13.	Robotics: Design, Construction and Applications	Allie Weaver	Willford Press 2022 ISBN 9781682860944
14.	Modern Robotics: Mechanics, Systems and Control	Julian Evans	Larsen and Keller Education 2022 ISBN 9781641728515
15.	Introduction to Mechatronics	Randy Dodd	Larsen and Keller Education 2022 ISBN 9781641728493
16.	Introduction to Robotics	Julian Evans	Larsen and Keller Education 2022 ISBN 9781641728503

(b) Online Educational Resources:

1. https://web.iitd.ac.in/~saha/ethiopia/appln.pdf
2. https://nptel.ac.in/courses/112105249
3. https://www.robotsscience.com/industrial/industrial-robots-types-applications-benefits-and-future/
4. https://www.marian.ac.in/public/images/uploads/pdf/online-class/MODULE-6%20ROBOTICS%20INDL_APPLNS-converted.pdf
5. https://forcedesign.biz/blog/5-common-industrial-robot-applications
6. https://www.hitechnectar.com/blogs/top-industrial-robotics-applications-role-of-robots-in-manufacturing/
7. https://en.wikipedia.org/wiki/Industrial_robot

8. https://www.youtube.com/watch?v=fH4VwTgfyrQ
9. https://www.youtube.com/watch?v=aW_BM_S0z4k
10. https://www.automate.org/industry-insights/smarter-robot-grasping-with-sensors-software-the-cloud
11. https://robots.ieee.org/robots/?t=all
12. https://www.youtube.com/watch?v=fc_Cynqr6jM

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested OER, before use by the students.

(c) Others:

1. Learning Packages:
- https://www.edx.org/learn/robotics
- https://www.coursera.org/courses?query=robotics
- https://www.udemy.com/topic/robotics/
- https://library.e.abb.com/public/9a0dacfdec8aa03dc12578ca003bfd2a/Learn%20with%20ABB.%20Robotic%20package%20for%20education.pdf

2. Users' Guide:
- https://roboindia.com/store/DIY-do-it-your-self-educational-kits-robotics-embedded-system-electronics
- https://www.robomart.com/diy-robotic-kits
- https://www.scientechworld.com/robotics

3. Lab Manuals:
- http://www-cvr.ai.uiuc.edu/Teaching/ece470/docs/ROS_LabManual.pdf
- https://www.jnec.org/labmanuals/mech/be/sem1/Final%20Year%20B.Tech-ROBOTICS%20LAB%20%20MANUAL.pdf

S) Course Curriculum Development Team (NITTTR, Bhopal)

- Dr. Nishith Dubey (Coordinator)
- Prof. (Mrs.) Susan S. Mathew (Co-Coordinator)
- Dr. Sharad Pradhan

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PUBLIC HEALTH ENGINEERING LAB

Subject Code 2015608 A	Practical			No of Period in one session: 56			Credits
	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal (PA)	:	20	
	—	—	04	External (ESE)	:	30	

Course Objectives:

Following are the objectives of this course:
• To learn the tests for measuring quality of drinking water.
• To learn determination of BOD and COD requirement in sewage.
• To understand the plotting of water supply scheme highlighting different features.

CONTENTS: PRACTICAL

List of practical's to be performed (Any Eight):

1	Determine pH value of given sample of water.
2	Determine the turbidity of the given sample of water.
3	Determine residual chlorine in a given sample of water.
4	Determine suspended, dissolved solids and total solids of given sample of water.
5	Determine the dissolved oxygen in a sample of water.
6	Determine the optimum dose of coagulant in a given raw water sample by jar test.
7	Draw sketches of various valves used in water supply pipe line
8	Draw a sketch of one pipe and two pipe system of plumbing
9	Determine B.O.D. of given sample of sewage.
10	Determine C.O.D. of given sample of sewage.
11	Determine pH value of given sample of sewage.
12	Undertake a field visit to water treatment plant and prepare a report.
13	Prepare a report of a field visit to sewage treatment plant

Suggested learning resources:

1. Sharma S.C, Environmental Engineering, Khanna Publishing House, New Delhi
2. Garg, S.K., Environmental Engineering Vol. I and Vol. II, Khanna Publishers
3. Birdie, G. S. and Birdie, J. S. Water Supply and Sanitary Engineering, Dhanpat Rai
4. Gupta, O.P., Elements of Environmental Pollution Control, Khanna Publishing House, Delhi
5. Rao, C.S., Environmental Pollution Control Engineering, New Age International
6. Punmia, B C, Environmental Engineering, vol. I and II, Laxmi Publishers
7. Peavy H S, Rowe D R, and Tchobanoglous G, Environmental Engineering, McGraw
8. Basak N N, Environmental Engineering, McGraw Hill Publishers.

Course outcomes:

After completing this course, student will be able to:

CO 1 : Perform various tests to assess quality of water.

CO 2 : Estimate dissolved solids as per BIS codes.

CO 3 : Measure BOD and COD of sewage sample.

CO 4 : Draw line diagram of water pipeline system for a locality.

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TERM WORK
SEMINAR

Subject Code 2015609	Practical			No of Period in one session: 56			Credits
	No. of Periods Per Week			**Full Marks**	:	50	02
	L	**T**	**P/S**	**Internal (PA)**	:	15	
	—	—	04	**External (ESE)**	:	35	

Course objectives:

A seminar is a form of academic instruction, either at an academic institution or offered by an institutional commercial or professional organization. The term *seminar* is also used to describe a research talk, often given by a visiting researcher and primarily attended by academics, research staff, and students. Seminars often occur in regular series, but each seminar is typically given by a different speaker, on a topic of that speaker's choosing.

Following are the objectives of this course: -
- To develop good skill of delivering impressive presentation.
- To improve the communication skill of students.
- To make the students confident while presenting among mass.

CONTENTS: TERM WORK

Suggested seminar topics (At least One): Any distinct topic from the field of civil engineering (Diploma Level) can be selected for the seminar presentation depending upon the choice of students. The students also have to prepare the seminar report on the selected seminar topic in a standard format as guided by the concerned faculty. However few seminar topics as examples are listed here for the ready reference: -

- Urban Design
- Advance Construction Techniques
- Advanced Earthquake Resistant Techniques
- Evacuation Patterns in High Rise Buildings
- Fiber Reinforced Concrete
- Concrete Repair and Structural Strengthening
- Carbon Fibre Use in Constructions
- Hydrology
- Hazardous Waste Management
- Submerged Floating Tunnels
- Disaster Management
- Suspension Bridges
- Highway Network Management
- Pavement Design
- Bamboo as a Building Material
- Low-Cost Housing
- Canal Irrigation
- Rainwater Harvesting
- Nanotechnology in Civil Engineering
- Parking Problems
- Transparent Concrete
- High-Performance Concrete
- Geotextiles
- Optimization of Water Resource Systems
- Defluorination Of Ground Water

- ☐ Noise Control of Buildings
- ☐ Green Concrete
- ☐ Demolition of Buildings
- ☐ Lightweight Concrete
- ☐ Solar Energy
- ☐ Use of Remote Sensing for Irrigation Water Allotment
- ☐ Engineering Modelling of Earthquake Source
- ☐ Condition Assessment of Railway Bridges
- ☐ Design of Efficient Surface Aerators For Waste Water Treatment
- ☐ Structured Irrigation Network
- ☐ High Rise Buildings
- ☐ Ground Improvement Techniques
- ☐ Solid Waste Management etc.

Suggested learning resources:

1. https://leverageedu.com/blog/seminar-topics-for-civil-engineering/
2. https://www.seminarsonly.com/Civil_Engineering/Civil_engineering_seminar_topics.php
3. https://www.seminarstopics.com/branch/5/civil-engineering-seminars/
4. https://www.slideshare.net/asertseminar/15-best-new-seminar-topics-for-civil-engineering

Course outcomes:

After completing this course, student will be able to:

CO 1 : To present the seminar impressively.
CO 2 : To prepare the seminar report.
CO 3 : To communicate at mass platform well

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MAJOR PROJECT

Subject Code 2015610	Practical						Credits 03
	No. of Periods Per Week			Full Marks	:	50	
	L	T	P/S	Internal (PA)	:	15	
	—	—	6	External (ESE)	:	35	
	—	—	—				

Course objectives:

The projects if done right can help enthusiastic civil engineering students to develop the skills/profile needed for an exciting career in core technologies. Since practical skills are very important to work on core industries. These projects provide an excellent opportunity to learn and showcase practical skills to the industry. The best way to master a subject is by doing projects. Through a project one not only gets a deeper understanding of the subject but also gains hands-on practical experience.

Projects are generally done as a combined team effort. A group of 4 to 6 students work under a guide or a staff to get a certain result. The course objective of this course are as follows: -

- To understand the learnings of civil engineering domain better
- To enable the students to do hands-on practical works and to gain practical experience
- To provide the chance to showcase the skills obtained
- To Learn about team work, communication skills and responsibilities.

CONTENTS: TERM WORK

The students can do any kind of projects based on their area of interests or subjects from civil engineering domain. The project can be selected from any civil engineering system like Building construction system, transportation engineering system, irrigation engineering system. A topic for project can also be selected on recent development in civil engineering.

Following is the list /areas of suggested civil engineering projects to be undertaken by a group of 4 to 6 students:

1) K.T. (Kolhapur-Type) Weir
2) Lift Irrigation scheme.
3) Micro irrigation –Drip/Sprinkler Irrigation.
4) Junction planning for city roads/planning for roads for congested area/parking Studies etc.
5) Water shed development of small catchments.
6) Rain water harvesting for domestic or public building.
7) Campus development.
8) Interior decoration.
9) Concrete mix design.
10) Bridge design.
11) NDT of any RCC building.
12) Solid waste management.
13) Hospital waste disposal.
14) Recycling of resources.
15) Manufacturing of Pre-cast concrete products.
16) Prestressed concrete.
17) Non-conventional sources of energy.

18) Concrete pipe manufacturing unit.
19) Advance construction techniques.
20) Transfer of technology to villages.
21) Planning and design for residential apartments/commercial complex.
22) Planning and design of water treatment plant for given data.
23) Planning and design of water supply scheme for given lay out.
24) Planning and design of sewage treatment plant for given data.
25) Planning and design of sanitary scheme for given lay out etc.

Any other similar project can be selected. The project report shall be in the following format:
- Topic and objectives
- Methodology- Collection of data, required survey work etc.
- Management and construction procedure
- Resources scheduling and networking
- Design details
- Required drawing set
- Utility to society if any
- Conclusion

Term Work: Shall consist of ------ Detailed project report in above format.

Learning Resources:
1) Civil Engineering Hand Books / Reference books.
2) Civil Engineering Magazines
3) Relevant IS / International codes.
4) PWD Handbooks / M.I.Manuals
5) Material / Machinery / Product Catalogue.
6) https://www.researchgate.net/

Course outcomes:
After completing this course, student will be able to:

CO 1 : To decide and collect data for projects.

CO 2 : To read and interpret the drawing data.

CO 3 : To design the components.

CO 4 : To apply the principles, rules, regulations and byelaws.

CO 5 : To plan for different phases of a task.

CO 6 : To prepare drawings for project.

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TERM WORK

Course Under Moocs /NPTEL/ Others TW

Subject Code	Practical			No. of Period in one Session :			Credits
2015611	**No. of Periods Per Week**			**Full Marks**	**:**	**50**	**01**
	L	**T**	**P/S**	**Internal (PA)**	**:**	**20**	
	—	—	**2**	**External (ESE)**	**:**	**30**	

PROGRAM ELECTIVE (TERM WORK)

TENDERING AND ACCOUNTS-TW

Subject Code	Term Work						Credits
2015612A	No. of Periods Per Week			Full Marks	:	50	02
	L	T	P/S	Internal(PA)	:	15	
	—	—	4	External(ESE)	:	35	

Course Objectives:

Following are the objectives of this course:
- To understand terminologies in contract and tender document and their significance.
- To know different types of contract forms and their uses.
- To learn preparation to typical Tender document for civil engineering work.
- To know the store procedure of PWD.

CONTENTS: TERM WORK

List of term works to be performed (Any Five):

1	Collecting old set of tender document and writing a report on it.
2	Collection of tender notices published in newspapers for various items of civil engineering works. (at least 5) write salient features of them.
3	Drafting a tender notice for construction of a civil engineering work (W. B. M. Road, residential building).
4	Preparation of tender document for the building. (detailed estimate prepared for RCC building in estimating and costing shall be used).
5	Collection of various account forms from PWD & writing report on it.
6	Prepare a report on store procedure and account procedure of PWD.

Suggested Text Book/ Reference Book:
1. Datta, B. N., Estimating and Costing in Civil engineering, UBS Publishers Pvt. Ltd., New Delhi
2. Raina, V. K., Construction Management and Contract Practices, Shroff Publishers & Distributers Pvt. Ltd.
3. Rangawala, S. C., Estimating and Costing, Charotar Publishing House PVT. LTD., Gujrat
4. Birdie, G. S., Estimating and Costing, Dhanpat Rai Publishing Company(P) Ltd., New Delhi
5. Patil, B. S., Civil Engineering Contracts and Estimates, Orient Longman, Mumbai
6. Chakraborti, M., Estimating and Costing, Specification and Valuation in Civil Engineering, Monojit Chakraborti, Kolkata.

Course outcomes:

After completing this course, student will be able to:

CO 1 : To understand terminologies in contract and tender document and their significance.

CO 2 : To know different types of contract forms and their uses.

CO 3 : To learn preparation to typical Tender document for civil engineering work.

CO 4 : To know the store procedure of PWD.

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PROGRAM ELECTIVE (TERM WORK) ADVANCED DESIGN OF STRUCTURES-TW

Subject Code	Term Work						Credits
2015612B	**No. of Periods Per Week**			**Full Marks**	**:**	**50**	**02**
	L	**T**	**P/S**	**Internal(PA)**	**:**	**15**	
	—	—	**4**	**External(ESE)**	**:**	**35**	

Course Objectives:

Following are the objectives of this course:
- To understand the concepts involved in the design of riveted and welded connections.
- To know the provisions of IS codes
- To design T and L shaped beam sections, One- and two-way slab.
- To understand the concept for design of one way and two-way slabs.

CONTENTS: TERM WORK

List of term work to be performed (Any Five):

1	Design of riveted connections with neat sketches/drawings.
2	Design of welded connections with neat sketches/drawings.
3	Design of L shaped RCC beam sections with neat sketches/drawings.
4	Design of T shaped RCC beam sections with neat sketches/drawings.
5	Design of one way RCC slabs with neat sketches/drawings.
6	Design of two way RCC slabs with neat sketches/drawings.
7	Design of RCC column with an isolated footings with neat sketches/drawings.

Note:- Here any suitable standard dimensions can be assumed for design purpose.

Suggested Text Book/ Reference Book:
1. Shah, V. L., and Gore, V., Limit State Design of Steel Structures, Structures Publications, Pune.
2. Dayarathnam, P., Design of Steel Structures, S. Chand and Company, New Delhi.
3. Subramanian N., Design of Steel Structures, Oxford University Press.
4. Sairam, K.S., Design of Steel Structures, Pearson Publication, Chennai, Delhi.
5. Shah, V. L., and Karve, S.R., Limit State Theory and Design of Reinforced Concrete Structures, Structures Publications, Pune.
6. Sinha N.C., and Roy S.K., Fundamentals of Reinforced Concrete, S. Chand & Co.,
7. Krishna Raju, and N.Pranesh, R.N., Reinforced Concrete Design Principles and Practice, New Age International, Mumbai.
8. Pillai, S.U., and Menon, Devdas, Reinforced concrete Design, McGraw Hill
9. Varghese, P. C., Limit State Design of Reinforced Concrete, Prentice Hall India Learning Private Limited, Delhi.

E-REFERENCES: -

- http://www.nptelvideos.in/2012/11/design-of-steel-structures.html
- https://nptel.ac.in/courses/

Course outcomes:

After completing this course, student will be able to perform:
- Design of riveted and welded connections.
- Design of T and L shaped beam sections.
- Design of one way and two way slabs.
- Design of RCC column and isolated footings.