

Curriculum
of
Diploma Programme
in
Electronic (Robotics) Engineering



State Board of Technical Education (SBTE)
Bihar

Semester – IV Teaching & Learning Scheme

| Board of Study | CourseCodes | CourseTitles | Teaching & Learning Scheme (Hours/Week) | | | | | |
|----------------|----------------|--|--|----------|----------------------|------------------------|---------------------------|-------------------|
| | | | Classroom Instruction (CI) | | Lab Instruction (LI) | Notional Hours (TW+SL) | Total Hours (CI+LI+TW+SL) | Total Credits (C) |
| | | | L | T | | | | |
| | 2421401 | Linear Integrated Circuits (ELX, ELX (R)) | 3 | - | 4 | 2 | 9 | 6 |
| | 2421402 | Microcontroller and its Applications (ELX, ELX (R)) | 3 | - | 4 | 2 | 9 | 6 |
| | 2443403 | Hydraulic & Pneumatic Controls | 3 | - | 4 | 2 | 9 | 6 |
| | 2418305 | Python Programming (CE, CSE, AIML, ME, ME (Auto)., ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT) | 3 | - | 4 | 2 | 9 | 6 |
| | 2425406 | Mechanics of Materials | 3 | - | - | 2 | 5 | 4 |
| | 2400007 | Indian Constitution (Common for All Programmes) | 1 | - | - | - | 1 | 1 |
| | 2400110 | Community/ Society Development (Non-exam course) (AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM) | 1 | - | - | - | 1 | 1 |
| Total | | | 17 | - | 16 | 10 | 43 | 30 |

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.

Semester - IV Assessment Scheme

| Board of Study | Course Codes | Course Titles | 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) | |
| | 2421401 | Linear Integrated Circuits (ELX, ELX (R)) | 30 | 70 | 20 | 30 | 20 | 30 | 200 |
| | 2421402 | Microcontroller and its Applications (ELX, ELX (R)) | 30 | 70 | 20 | 30 | 20 | 30 | 200 |
| | 2443403 | Hydraulic & Pneumatic Controls | 30 | 70 | 20 | 30 | 20 | 30 | 200 |
| | 2418305 | Python Programming (CE, CSE, AIML, ME, ME (Auto)., ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT) | 30 | 70 | 20 | 30 | 20 | 30 | 200 |
| | 2425406 | Mechanics of Materials | 30 | 70 | 20 | 30 | - | - | 150 |
| | 2400007 | Indian Constitution (Common for All Programmes) | 25 | - | - | - | - | - | 25 |
| | 2400110 | Community/ Society Development (Non-exam course) (AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM) | 25 | - | - | - | - | - | 25 |
| Total | | | 200 | 350 | 100 | 150 | 80 | 120 | 1000 |

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:

- 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.

- A) **Course Code** : 2421401(T2421401/P2421401/S2421401)
 B) **Course Title** : Linear Integrated Circuits (ELX, ELX (R))
 C) **Pre- requisite Course(s)** : Basic Electronics, Analog Electronics
 D) **Rationale** :

Linear Integrated Circuits, often referred to as analog integrated circuits, serve as fundamental building blocks in electronic systems. An op-amp is the most versatile Linear Integrated circuit used to develop various applications in electronics circuits and equipment. Hence this course is intended to develop the skill to build, test, diagnose, and rectify the Op-amp based electronic circuit and deals with various aspects of Linear Integrated Circuits used in various industrial, consumer, and domestic applications.

- 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** Interpreted the step by step procedurals involved in IC fabrication.
CO-2 Use various configurations of Op-Amp for different applications.
CO-3 Troubleshoot various Op-Amp circuits for a given application.
CO-4 Use Op-Amp IC to design filters and oscillators.
CO-5 Use Multivibrator, PLL and VCO circuit for various 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 | - | 3 | 2 | 3 | - | 2 | | |
| CO-2 | 3 | 2 | - | 2 | - | - | - | | |
| CO-3 | 3 | 3 | - | 2 | - | - | - | | |
| CO-4 | 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 is optional

- G) **Teaching & Learning Scheme:**

| Board of Study | Course Code | Course Title | Teaching & Learning Scheme (Hours/Week) | | | | | |
|-------------------------|-------------|--------------------|---|---|----------------------|-------------------------|---------------------------|-------------------|
| | | | Classroom Instruction (CI) | | Lab Instruction (LI) | Notional Hours (TW+ SL) | Total Hours (CI+LI+TW+SL) | Total Credits (C) |
| | | | L | T | | | | |
| Electronics Engineering | 2421401 | Analog Electronics | 03 | - | 04 | 02 | 09 | 06 |

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) | |
| Electronics Engineering | 2421401 | Linear Integrated Circuits | 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:

- 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: T2421401

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|---|------------------------|
| <p><i>TSO 1a.</i> List the advantages of ICs over discrete components.</p> <p><i>TSO 1b.</i> Describe the processes involved in manufacturing of monolithic ICs.</p> <p><i>TSO 1c.</i> Describe the process of construction of monolithic bipolar transistor.</p> <p><i>TSO 1d.</i> Describe the process of construction of monolithic diode with the help of a transistor.</p> | <p>Unit-1. IC Fabrication</p> <p>1.1 Advantages of ICs over discrete components</p> <p>1.2 Classification of ICs on the basis of complexity: SSI, MSI, LSI, VLSI, ULSI</p> <p>1.3 Fabrication process of monolithic ICs</p> <ul style="list-style-type: none"> • Wafer Preparation • Epitaxial growth • Oxidation • Photolithography • Diffusion • Metallization • Circuit Probing • Scribing and separating into chips • Mounting and Packaging • Encapsulation <p>1.4 Step by step construction procedures of monolithic bipolar transistor, diode, capacitors and Integrated resistors</p> <p>1.5 Sustainable process in IC fabrication</p> | CO-1 |
| <p><i>TSO 2a.</i> Select the Op-Amp based on Op-AMP parameters for the given application.</p> <p><i>TSO 2b.</i> Describe with sketches the working of Op-Amp in various configurations.</p> <p><i>TSO 2c.</i> Describe with sketches the working of Op-Amp in various modes.</p> <p><i>TSO 2d.</i> Calculate the output voltage of the given inverting and Non-Inverting Op-amp.</p> <p><i>TSO 2e.</i> Calculate the output voltage of Op-Amp circuit with the help of virtual ground concept.</p> | <p>Unit 2 Fundamentals of Operational Amplifier</p> <p>2.1. Operational Amplifier: - Block diagram, Equivalent Circuit, Symbol, and basic terminology</p> <p>2.2. Op-Amp IC 741 pin diagram and description</p> <p>2.3. Op-Amp Configuration: Open Loop and Closed Loop, virtual ground concept</p> <p>2.4. Op-Amp parameters: Input offset voltage, input offset current, input bias current, input resistance, Output Resistance, Open Loop voltage gain (Differential gain), Common mode gain, Common Mode Rejection Ratio (CMRR), Maximum output voltage Swing, Slew Rate</p> <p>2.5. Parameters of Ideal and Practical Op-Amp</p> <p>2.6. Modes of operations: Inverting and Non-Inverting</p> | CO-2 |
| <p><i>TSO 3a.</i> Calculate the output voltage of the given arithmetic circuit containing Op-Amp.</p> <p><i>TSO 3b.</i> Explain with sketches the output of an Instrumentation amplifier.</p> <p><i>TSO 3c.</i> Choose a relevant Op-Amp converter for the given application with justification.</p> <p><i>TSO 3d.</i> Describe with sketches the working of Op-Amp as a comparator, peak detector, and zero crossing detector.</p> <p><i>TSO 3e.</i> Describe the various applications of the Op-Amp circuit with the circuit diagram and I/O waveforms.</p> | <p>Unit-3 Applications of Op-Amp</p> <p>3.1 Arithmetic Operations Circuit: Adder, Subtractor, Scaler, Integrator, Differentiator</p> <p>3.2 Differential amplifier, Voltage Follower (Unity Gain Amplifier)</p> <p>3.3 Op-amp as an Instrumentation amplifier: Working, Derivation of output voltage</p> <p>3.4 Voltage to Current converter with floating and grounded load</p> <p>3.5 Current to Voltage converter</p> <p>3.6 Logarithmic Amplifier and Anti-Logarithmic Amplifier using diodes</p> <p>3.7 Comparator</p> <p>3.8 Zero Crossing Detector</p> | CO2, CO3 |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|--|------------------------|
| | 3.9 Schmitt Trigger 3.10 Peak Detector 3.11 Sample and Hold Circuit | |
| <p><i>TSO 4a.</i> Describe the working of the given type of filter with sketches.</p> <p><i>TSO 4b.</i> Explain with sketches procedure to identify the given type of filter based on frequency response.</p> <p><i>TSO 4c.</i> Calculate the cutoff frequency of the given type of filter.</p> <p><i>TSO 4d.</i> Describe with sketches the working principle of the given type of oscillator.</p> <p><i>TSO 4e.</i> Calculate the frequency of oscillation of the given type of oscillator.</p> | <p>Unit-4. Filters and Waveform Generators using Op-Amp</p> <p>4.1 Filter and its classification</p> <p>4.2 Merits and demerits of active filters over passive filters</p> <p>4.3 Responses of Ideal and Practical filters</p> <p>4.4 Filters Characteristic terms: Order of filter, cutoff frequency, Passband, Stopband, Centre frequency, Bandwidth, Q factor</p> <p>4.5 Filter types and their Frequency Response</p> <ul style="list-style-type: none"> • Low Pass (First Order and Second Order) • High Pass (First Order and Second Order) • Band Pass (Wide and Narrow) • Band Reject (Wide and Narrow) • All Pass filter <p>4.6 Oscillators using IC 741</p> <ul style="list-style-type: none"> • R-C Phase Shift Oscillator • Wein Bridge Oscillator • Colpitts Oscillator • Hartley Oscillator | CO-4 |
| <p><i>TSO 5a.</i> Describe with sketches the working of the analog multiplier.</p> <p><i>TSO 5b.</i> Explain with sketches the working of IC-555 for the given application.</p> <p><i>TSO 5c.</i> Calculate the duty cycle of the given type of multivibrator.</p> <p><i>TSO 5d.</i> Describe with sketches the working of voltage controlled oscillator.</p> <p><i>TSO 5e.</i> Explain with sketches the working of given blocks of PLL.</p> <p><i>TSO 5f.</i> Explain the working of the given type of multivibrator and compare their speed of operations.</p> <p><i>TSO 5g.</i> Explain with sketches the working of OTA for the given application.</p> | <p>Unit-5 Special function ICs and their Applications</p> <p>5.1 Analog multiplier</p> <ul style="list-style-type: none"> • Introduction • Pin diagram and pin function of analog multiplier IC AD633 <p>5.2 IC-555</p> <ul style="list-style-type: none"> • Functional Block diagram • Pin diagram and functions of Timer <p>5.3 Multivibrators using IC-555</p> <ul style="list-style-type: none"> • Astable Multivibrator • Monostable Multivibrator • Bistable Multivibrator <p>5.4 Voltage Controlled Oscillator(VCO)</p> <ul style="list-style-type: none"> • Introduction • Pin Diagram of NE/SE566 VCO • Basic block diagram • Operation of VCO <p>5.5 Phase Lock Loop (PLL)</p> <ul style="list-style-type: none"> • Block diagram and its operation, Lock range and capture range • Pin diagram and Function of IC 565 • Applications of IC 565 PLL as a Frequency multiplier and FM Demodulator <p>5.7 Introduction to OTA (IC-CA3080A) and its Applications</p> | CO-5 |

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2421401

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant Cos Number(s) |
|---|--------|---|------------------------|
| LSO 1.1. Measure input and output offset voltage. LSO 1.2. Calculate CMRR. | 1. | Measure input offset voltage, output offset voltage, and common mode rejection ratio (CMRR) of op-amp IC-741. | CO2 |
| LSO 2.1. Measure the peak-to-peak voltage of the output waveform on CRO. | 2. | Measure the Output voltage swing parameter of op-amp IC-741 | CO2 |
| LSO 3.1. Measure the output voltage for various input voltages of inverting amplifier and non-inverting amplifier circuit. LSO 3.2. Determine the gain of the inverting amplifier and non-inverting amplifier. | 3. | Measure the output voltage of Inverting and non Inverting OP-Amp for the given Input. | CO2 |
| LSO 4.1. Construct the adder circuit using IC-741. LSO 4.2. Measure the output voltage of the adder circuit and compare it with theoretical calculation. | 4. | 1. a) Test IC-741 using IC tester, b) Build/Test adder and subtractor circuit consist of IC-741. | CO3 |
| LSO 5.1. Measure the output voltage of integrator circuit for different input waveforms. | 5. | Build/Test Integrator circuit consists of IC-741. | CO3 |
| LSO 6.1. Measure the output voltage of differentiator circuits for different input waveforms. | 6. | Build/Test Differentiator circuit consists of IC-741. | CO3 |
| LSO 7.1. Test voltage to current converter circuit & and verify the measured value with calculated output. LSO 7.2. Test current to voltage converter circuit and verify the measured value with the calculate output. | 7. | Build/Test Voltage to Current converter and Current to Voltage converter circuit consist of IC-741. | CO3 |
| LSO 8.1. Interpreted and analyze the output of the Zero crossing detector and active positive peak detector. | 8. | Build/Test comparator circuit consist of IC-741 as Zero crossing detector and active positive peak detector. | CO3 |
| LSO 9.1. Interpreted and analyze the output of the Instrumentation amplifier circuit. | 9. | Build/Test Instrumentation amplifier circuit using IC LM324. | CO3 |
| LSO 10.1. Measure the bandwidth of first order low pass filter. | 10. | Measuring of the bandwidth and cutoff frequency for a given first order low pass filter. | CO4 |
| LSO 11.1. Interpreted and analyze the output of the second-order low pass filter. | 11. | Build and test 2 nd order active low pass filter using IC-741 Op-Amp. | CO4 |
| LSO 12.1. Interpreted and analyze the output of first order high pass filter. | 12. | Measuring of the bandwidth and cutoff frequency for a given first order high pass filter. | CO4 |
| LSO 13.1. Interpreted and analyze the output of the second order high pass filter. | 13. | Build and test a 2 nd order active high pass filter using IC-741 Op-Amp. | CO4 |
| LSO 14.1. Interpreted and analyze the output of the second order band pass filter. | 14. | Build and test 2 nd order active bandpass filter using IC-741 Op-Amp | CO4 |
| LSO 15.1. Interpreted and analyze the output of second order band reject filter. | 15. | Build and test a 2 nd order active band reject filter using IC-741 Op-Amp. | CO4 |
| LSO 16.1. Measure the frequency of oscillation of the RC Phase shift oscillator using IC 741. | 16. | Measuring of the frequency of oscillation for given RC Phase shift oscillator circuit using IC-741. | CO5 |

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant Cos Number(s) |
|---|--------|--|------------------------|
| <i>LSO 17.1</i> Measure the frequency of oscillation of Wien Bridge oscillator. | 17. | Build and test Wien bridge oscillator circuit using IC-741 and Measure output frequency. | CO5 |
| <i>LSO 18.1</i> Measure the frequency and duty cycle for a given waveform. | 18. | Build/Test an astable multivibrator using IC-555 for the given specifications | CO5 |
| <i>LSO 19.1</i> Measure the frequency and duty cycle for a given waveform, monostable multivibrator circuit using IC-555. | 19. | Build/Test monostable multivibrator using IC-555 for the given specifications. | CO5 |
| <i>LSO 20.1</i> Measure the frequency and duty cycle for a given waveform. | 20. | Build/Test an astable multivibrator using IC-555 for the given specifications | CO5 |

L) Suggested Term Work and Self Learning: S2421401 Some sample suggested assignments, micro projects 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. Write applications of astable, bistable and monostable multivibrator.
- ii. Describe the working of RC phase shift and Wein Bridge oscillator.
- iii. Draw the frequency response waveform of first order LPF and HPF.

b. Micro Projects:

- i. Develop a temperature control DC fan using IC 741
- ii. Develop a tone generator using IC 555
- iii. Develop a sound sensor using IC LM324 and a microphone.
- iv. Build a frequency synthesizer using PLL IC 565.
- v. Prepare a survey report on commercial ICs available in the local market with specifications and specific applications.

c. Other Activities:

1 Seminar:

- i. Op-amp and its applications.
- ii. Commercially available Op-amp ICs.
- iii. VLSI technologies and their future aspects.
- iv. Usage of ICs in consumer and industrial electronics appliances.

2 Industrial Visits:

- i. Visit a nearby tool room/industry with IC fabrication facilities.
- ii. Prepare a report on different IC fabrication techniques used in industries.

3 Self-learning topics:

- i. Internet survey of Op-amp based linear circuit and their applications.
- ii. Read the datasheet of various linear ICs.
- iii. Test electronics equipment and components through a multimeter.

- 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 | 15% | 15% | 15% | - | - | - | - |
| CO-2 | 10% | 15% | 10% | 25% | - | 20% | 25% |
| CO-3 | 15% | 20% | 15% | 25% | 33% | 20% | 25% |
| CO-4 | 30% | 25% | 30% | 25% | 33% | 30% | 25% |
| CO-5 | 30% | 25% | 30% | 25% | 34% | 30% | 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 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 IC Fabrication | 8 | CO1 | 10 | 4 | 4 | 2 |
| Unit-2.0 Fundamentals of Operational Amplifier | 8 | CO2 | 12 | 4 | 4 | 4 |
| Unit-3.0 Linear and non-linear applications of Op-Amp | 10 | CO1, CO2 | 14 | 4 | 4 | 6 |
| Unit-4.0. Filters and Waveform Generators using Op-Amp | 10 | CO3, CO4 | 18 | 4 | 8 | 6 |
| Unit-5.0 Special function ICs and their applications | 12 | CO4, CO5 | 16 | 4 | 6 | 6 |
| Total Marks | 48 | - | 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):

| S. No. | Laboratory Practical Titles | Relevant COs Number (s) | PLA/ELA | | |
|--------|---|-------------------------|-------------|------------|---------------|
| | | | Performance | | Viva-Voce (%) |
| | | | PRA * (%) | PDA ** (%) | |
| 1. | Measure input offset voltage, output offset voltage, and common mode rejection ratio (CMRR) of op-amp IC-741. | CO2 | 60 | 40 | 10 |
| 2. | Measure the Output voltage swing parameter of op-amp IC-741 | CO2 | 60 | 40 | 10 |
| 3. | Measure the output voltage of Inverting and non Inverting OP-Amp for the given Input. | CO2 | 60 | 40 | 10 |
| 4. | 1. a)Test IC-741 using IC tester,b)Build/Test adder and subtractor circuit consist of IC-741. | CO3 | 60 | 40 | 10 |
| 5. | Build/Test Integrator circuit consists of IC-741. | CO3 | 60 | 40 | 10 |
| 6. | Build/Test Differentiator circuit consists of IC-741. | CO3 | 60 | 40 | 10 |
| 7. | Build/Test Voltage to Current converter and Current to Voltage converter circuit consist of IC-741. | CO5 | 60 | 40 | 10 |
| 8. | Build/Test comparator circuit consist of IC-741 as Zero crossing detector and active positive peak detector. | CO5 | 60 | 40 | 10 |
| 9. | Build/Test Instrumentation amplifier circuit using IC LM324. | CO5 | 60 | 40 | 10 |
| 10. | Measuring of the bandwidth and cutoff frequency for a given first order low pass filter. | CO5 | 60 | 40 | 10 |
| 11. | Build and test 2 nd order active low pass filter using IC-741 Op-Amp. | CO3 | 60 | 40 | 10 |
| 12. | Measuring of the bandwidth and cutoff frequency for a given first order high pass filter. | CO3 | 60 | 40 | 10 |
| 13. | Build and test a 2 nd order active high pass filter using IC-741 Op-Amp. | CO3 | 60 | 40 | 10 |
| 14. | Build and test 2 nd order active bandpass filter using IC-741 Op-Amp | CO3 | 60 | 40 | 10 |
| 15. | Build and test a 2 nd order active band reject filter using IC-741 Op-Amp. | CO3 | 60 | 40 | 10 |
| 16. | Measuring of the frequency of oscillation for given RC Phase shift oscillator circuit using IC-741. | CO4 | 50 | 40 | 10 |
| 17. | Build and test Wien bridge oscillator circuit using IC-741 and Measure output frequency. | CO4 | 50 | 40 | 10 |
| 18. | Build/Test an astable multivibrator using IC-555 for the given specifications | CO4 | 50 | 40 | 10 |
| 19. | Build/Test monostable multivibrator using IC-555 for the given specifications. | CO4 | 50 | 40 | 10 |
| 20. | Build/Test an astable multivibrator using IC-555 for the given specifications | CO4 | 50 | 40 | 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 and Software | Broad Specifications | Relevant Experiment/Practical Number |
|--------|---------------------------------------|--|--------------------------------------|
| 1. | Variable DC power supply | 0-30V , 2A Dual Tracking power supply | ALL |
| 2. | Dual Power supply | ± 15V 2A Dual Tracking power supply | ALL |
| 3. | CRO | 0 to 20 MHz Dual Trace Oscilloscope & 100 MHz | ALL |
| 4. | DSO | 25 MHz/60 MHz/100 MHz 500MS/s to 1GS/s sample rate | ALL |
| 5. | Function Generator | 0- 2 MHz with sine , square and triangular output with variable frequency and amplitude | ALL |
| 6. | Function Generator | 20 MHz with sine , square and triangular output with variable frequency and amplitude | ALL |
| 7. | Digital multimeter | 4 ½ digit display , 9999 count, 0-30V, 10 A max , 0-100M Ohm | ALL |
| 8. | Electronic Work Bench | Bread board 840 1000 contact point , positive & negative power rails on opposite side of the board | ALL |
| 9. | IC 741C | Dual-In-Line or S.O. Package | ALL |
| 10. | Breadboard | 5.5 cm X 17 cm (minimum 1000 points) | ALL |
| 11. | Resistors | 82Ω, 1KΩ, 1.5KΩ, 3KΩ, 3.3KΩ, 10KΩ, 12KΩ, 15KΩ, 33KΩ, 39KΩ, 100KΩ | ALL |
| 12. | Potentiometer | 1KΩ, 10KΩ, 20KΩ, 50KΩ, 1MΩ | ALL |
| 13. | Capacitors | 0.01μF, 0.1μF, 1μF | ALL |
| 14. | Diode | 1N4007 | ALL |
| 15. | IC-555 | 8 Pin, DIP | ALL |
| 16. | IC LM324 | 14 Pin, DIP | ALL |
| 17. | Analog IC tester | Suitable to test analog ICs | ALL |
| 18. | Connecting Wires | Single stranded Teflon coating (0.6mm diameter) | ALL |

R) Suggested Learning Resources:**(a) Books:**

| S. No. | Titles | Author(s) | Publisher and Edition with ISBN |
|--------|---------------------------------------|-------------------------------------|---|
| 1. | Microelectronic Circuits | Adel S.Sedra & Kenneth C Smith | Oxford, 2014 ISBN: 978019939266 |
| 2. | Linear Integrated Circuits | Salivahanan S | McGra Hill, New delhi, 2008 ISBN: 9780070648180 |
| 3 | Linear Integrated Circuits | D.Roy Chaudhary, Jain, Sahil B . | New Age International Publishers, New delhi , 2003 ISBN:8122414702 |
| 4 | Op-Amp and linear integrated circuits | Gayakwad , Ramakant A | PHI Learning , New Delhi,2011 ISBN : 9788120320581 |
| 5 | Operational Amplifiers and Linear ICs | Bell, David A | Oxford university Press. New Delhi , India , 2011, ISBN: 9780195696134 |

(b) Online Educational Resources:

- 1)<https://nptel.ac.in/courses/117107094>
- 2)https://youtu.be/lpXNCwsnxjM?si=5U9VyrPe_zFcKMnx
- 3)<https://youtu.be/9SnR3M3Clm4?si=tw9pou4CKS7MHsty>

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational resources before use by the students.

- A) **Course Code** : 2421402(T2421402/P2421402/S2421402)
- B) **Course Title** : Microcontroller and its Applications (ELX, ELX (R))
- C) **Pre- requisite Course(s)** : Digital Electronics
- D) **Rationale:**

Microcontroller as a course is at the core of automation in industrial, domestic, consumer goods and other high-end products. Diploma engineers have to understand and apply the concepts of various microcontroller-based systems and maintain them. This course is meant to provide the basic and holistic approach and skills to solve the application problems related to automation systems based on microcontroller.

- 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 Analyze the architecture of Microprocessor IC 8085.
- CO-2 Analyze the architecture of Microcontroller IC 8051.
- CO-3 Develop program for 8051 in assembly language for the specified operations.
- CO-4 Develop program for 8051 using timer, Interrupt and serial or parallel ports.
- CO-5 Interface the memory and I/O devices to 8051 for microcontroller-based 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 | - | - | 2 | - | | |
| CO-2 | 3 | 2 | 2 | - | - | 2 | - | | |
| CO-3 | 3 | 3 | 2 | 3 | - | 2 | - | | |
| CO-4 | 3 | 3 | 2 | 3 | - | 2 | - | | |
| CO-5 | 3 | 2 | 1 | 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 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 | | | | |
| Electronics Engineering | 2421402 | Microcontroller and its Applications | 03 | - | 04 | 02 | 09 | 06 |

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) | |
| Electronics Engineering | 2421402 | Microcontroller and its Applications | 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:

- 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: T2421402

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|--|--|------------------------|
| <p><i>TSO 1a.</i> Interpret the general-purpose microprocessor and microcontroller.</p> <p><i>TSO 1b.</i> Differentiate between microprocessor and microcontroller.</p> <p><i>TSO 1c.</i> List different microcontrollers along with their typical features.</p> <p><i>TSO 1d.</i> Develop simple program using 8085 instructions.</p> | <p>Unit-1.0 Basics of Microprocessors and Microcontrollers</p> <p>1.1 Evolution of Processors (Microprocessors and Microcontrollers)</p> <p>1.2 Microprocessors and Microcontrollers comparisons.</p> <p>1.3 8085 Microprocessor:</p> <p> 1.3.1 Architecture & Pin Diagram</p> <p> 1.3.2 Register structure</p> <p> 1.3.3 8085 Addressing Modes</p> <p> 1.3.4 8085 Instruction set</p> <p> 1.3.5 Interrupt System</p> | CO1 |
| <p><i>TSO 2a.</i> Explain the architecture of 8051 microcontroller with block diagram representation.</p> <p><i>TSO 2b.</i> Classify the different types of MCS-8051 registers.</p> <p><i>TSO 2c.</i> Select the criteria for choosing a microcontroller.</p> <p><i>TSO 2d.</i> Describe special function registers.</p> <p><i>TSO 2e.</i> Explain the pin configuration of 8051 microcontroller with block diagram.</p> <p><i>TSO 2f.</i> Explain memory organization of 8051 microcontroller.</p> <p><i>TSO 2g.</i> Describe the Internal/External RAM & ROM organization of 8051 microcontroller.</p> | <p>Unit-2.0 8051 Microcontroller</p> <p>2.1 Families of 8051 Microcontroller</p> <p>2.2 Criteria for choosing a microcontroller</p> <p>2.3 Block diagram representation</p> <p>2.4 Pin configuration</p> <p>2.5 Architecture</p> <p>2.6 Registers:</p> <p> 2.6.1 General Purpose Registers</p> <p> 2.6.2 Stack Pointer and Program Counter</p> <p> 2.6.3 Special Function Registers (SFRs)</p> <p> 2.6.4 I/O Ports Structure</p> <p>2.7 Memory Organization:</p> <p> 2.7.1 Internal/External RAM organization</p> <p> 2.7.2 Internal/External ROM organization</p> | CO1, CO2 |
| <p><i>TSO 3a.</i> Classify the different types of instruction used in 8051.</p> <p><i>TSO 3b.</i> Differentiate addressing modes of 8051 microcontroller.</p> <p><i>TSO 3c.</i> Explain the timer operation of 8051 microcontroller.</p> <p><i>TSO 3d.</i> Differentiate between the serial and parallel communication modes of 8051.</p> <p><i>TSO 3e.</i> Describe Interrupt handling in 8051 microcontroller.</p> | <p>Unit-3.0 Instruction Set and Addressing Modes of 8051 Microcontroller</p> <p>3.1 Instruction Set:</p> <p> 3.1.1 Data Transfer Instructions</p> <p> 3.1.2 Conditional instructions</p> <p> 3.1.3 Arithmetic instructions</p> <p> 3.1.4 Logical instructions</p> <p> 3.1.5 Boolean instructions</p> <p>3.2 Different types of Addressing Modes:</p> <p> 3.2.1 Immediate Addressing Mode</p> <p> 3.2.2 Register Addressing Mode</p> <p> 3.2.3 Direct Addressing Mode</p> <p> 3.2.4 Indirect Addressing Mode</p> <p> 3.2.5 Indexed Addressing Mode</p> <p> 3.2.6 Relative Addressing Mode</p> <p> 3.2.7 Bit Addressing Mode</p> <p>3.3 Timers/Counters:</p> <p> 3.3.1 Types of Timers/Counters</p> <p> 3.3.2 TMOD Register</p> | CO3, CO4 |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|--|---|------------------------|
| | 3.3.3 TCON Register 3.4 Interrupts: 3.4.1 Types of interrupts 3.4.2 Interrupt handling | |
| <p><i>TSO 4a.</i> Difference between high level language and low-level language.</p> <p><i>TSO 4b.</i> Select structure of Assembly language.</p> <p><i>TSO 4c.</i> Explain the different microcontroller developing tools.</p> <p><i>TSO 4d.</i> Explain different assembler directives.</p> <p><i>TSO 4e.</i> Develop simple programs using 8051 instructions.</p> <p><i>TSO 4f.</i> Develop timer interrupt routines for periodic tasks.</p> | <p>Unit-4.0 8051 Microcontroller Assembly Language programming</p> <p>4.1 Programming in Microcontroller 8051</p> <p>4.1.1 Structure of Assembly language</p> <p>4.1.2 Low level/ High level Language</p> <p>4.1.3 Simple programming using instruction set</p> <p>4.1.4 Timer and counter programming</p> <p>4.2 Software Development Tools for 8051 Microcontroller</p> <p>4.2.1 Editor</p> <p>4.2.2 Assembler/Cross-Assembler</p> <p>4.2.3 Compiler/Cross-Compiler</p> <p>4.2.4 Debugger</p> <p>4.2.5 Simulator</p> | CO3, CO4 |
| <p><i>TSO 5a.</i> Explain the interfacing of 8051 microcontroller.</p> <p><i>TSO 5b.</i> Explain the keyboard interfacing with 8051 microcontrollers.</p> <p><i>TSO 5c.</i> Develop program to interface 7-segment display with 8051 microcontrollers with sketch.</p> <p><i>TSO 5d.</i> Develop program to interface sensor (e.g., temperature) with 8051 microcontrollers.</p> <p><i>TSO 5e.</i> Develop program to interface LCD with 8051 with sketch.</p> <p><i>TSO 5f.</i> Explain interfacing of ADC and DAC with 8051.</p> <p><i>TSO 5g.</i> Develop program to control stepper motor with 8051.</p> | <p>Unit 5.0 Interfacing of 8051 for Real Time Applications</p> <p>5.1 I/O Interfacing</p> <p>5.2 ROM/RAM Interfacing</p> <p>5.3 Keypad Interfacing</p> <p>5.4 7-segment LED display interfacing</p> <p>5.5 Sensor interfacing</p> <p>5.6 LCD interfacing</p> <p>5.7 ADC and DAC interfacing</p> <p>5.8 Stepper motor interfacing</p> | 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: P2421402

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|---|--------|--|------------------------|
| <i>LSO 1.1.</i> Identify the various components in 8085 Trainer Kit. | 1. | Verification of the features of 8085 Trainer Kit | CO1 |
| <p><i>LSO 2.1.</i> Write an ALP for 8085 to add two 8-bit numbers.</p> <p><i>LSO 2.2.</i> Test the results by executing the assembly language program.</p> | 2. | ALP based on Data transfer Instructions & Arithmetic Instructions(addition) in 8085 | CO1 |
| <p><i>LSO 3.1.</i> Write an ALP for 8085 to subtract two 8-bit numbers.</p> <p><i>LSO 3.2.</i> Test the results by executing the assembly language program.</p> | 3. | ALP based on Data transfer Instructions and arithmetic Instructions(subtraction) in 8085 | CO1 |
| <i>LSO 4.1.</i> Identify the various components in 8051 Trainer Kit. | 4. | Verification of the features of 8051 Trainer Kit | CO1, CO2 |

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|---|--------|--|------------------------|
| <p><i>LSO 5.1.</i> Write an ALP for 8051 to add two 8-bit numbers which is stored at two different memory locations and store the result (with carry & without carry cases) at another memory location.</p> <p><i>LSO 5.2.</i> Test the results by executing the assembly language program.</p> | 5. | ALP based on Data transfer Instructions & Arithmetic Instructions(addition) in 8051 | CO3, CO4 |
| <p><i>LSO 6.1.</i> Write and an ALP for 8051 to subtract two 8-bit Nos. which are stored at two different memory locations and store the result (with borrow & without borrow cases) at another memory locations.</p> <p><i>LSO 6.2.</i> Test the results by executing the assembly language program.</p> | 6. | ALP based on Data transfer Instructions and arithmetic Instructions(subtraction) in 8051 | CO3, CO4 |
| <p><i>LSO 7.1.</i> Develop an assembly language program to generate delay using timer in 8051 Microcontroller.</p> <p><i>LSO 7.2.</i> Test the results by performing assembly language program.</p> | 7. | Write an ALP to generate delay using Timer | CO3, CO4 |
| <p><i>LSO 8.1.</i> Build a program to interface a 7-segment display with 8051 Microcontroller</p> <p><i>LSO 8.2.</i> Test the results using an assembly language program.</p> | 8. | Interfacing 7 segment display with 8051 | CO3, CO4, CO5 |
| <p><i>LSO 9.1.</i> Build a program to interface a DC Motor with 8051 Microcontroller.</p> <p><i>LSO 9.2.</i> Test the result using an assembly language program to interface DC Motor with 8051.</p> | 9. | Interfacing a DC Motor with 8051. | CO3, CO4, CO5 |
| <p><i>LSO 10.1.</i> Build a program to interface a stepper Motor with 8051 Microcontroller.</p> <p><i>LSO 10.2.</i> Test the results by performing an assembly language program to interface Stepper Motor with 8051.</p> | 10. | Interfacing a Stepper Motor with 8051 | CO3, CO4, CO5 |
| <p><i>LSO 11.1.</i> Build a program to interface 8-bit DAC with 8051 Microcontroller.</p> <p><i>LSO 11.2.</i> Test the results by performing an assembly language program to interface 8-bit DAC with 8051.</p> | 11. | Interfacing 8-bit DAC with 8051 | CO3, CO4, CO5 |

L) Suggested Term Work and Self Learning: S2421402 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. Two samples are given below:

1. Compare microprocessor with microcontroller on the basis of:
 - Architecture wise
 - Application wise
 - Based on Von Neumann or Harvard
2. Make chart on evolution of processors on the basis of company wise with processor name and year wise.

b. Micro Projects:

1. Design a microcontroller-based line follower robot.
2. Build android-controlled two-axis pick and place robot.
3. Develop home appliances controlling using android mobile via Bluetooth.
4. Build an android-based ultrasonic distance meter with buzzer indication.
5. Build speed control of DC motor using android mobile.

c. Other Activities:

1. Seminar Topics:
 - Li-fi Data Transfer System.
 - IOT Based Person/Wheelchair Fall Detection.
 - IOT based Smart Energy Meter Monitoring with Theft Detection.
 - Health Monitoring System using 7-Segment Display & At mega Microcontroller.
 - Importance of Microcontroller 8051
2. Visits: Visit nearby tool room/industry with proper facilities, some of which are given below and prepare report.
 - TRTC (Tool Room and Training Centre)
 - Automatic vehicle industry
 - Microcontroller Lab, IIT Patna
3. Self- learning topics:
 - ATMEL
 - ATmega microcontroller
 - Comparison between 8085 & 8086.
 - Applications of microcontrollers in electronic industry.

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 | 20% | 15% | 15% | - | - | 15% | 20% |
| CO-2 | 25% | 20% | 10% | 25% | - | 10% | 20% |
| CO-3 | 25% | 25% | 15% | 25% | 33% | 20% | 20% |
| CO-4 | 15% | 20% | 30% | 25% | 33% | 25% | 20% |
| CO-5 | 15% | 20% | 30% | 25% | 34% | 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 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 Basics of Microprocessors and Microcontrollers | 8 | CO1 | 12 | 4 | 4 | 4 |
| Unit-2.0 8051 Microcontroller | 8 | CO1, CO2 | 12 | 4 | 4 | 4 |
| Unit-3.0 Instruction Set and Addressing Modes of 8051 Microcontroller | 12 | CO1, CO3 | 16 | 4 | 4 | 6 |
| Unit-4.0 8051 Microcontroller Assembly Language Programming | 10 | CO1, CO2 CO4 | 16 | 4 | 6 | 6 |
| Unit-5.0 Interfacing with Real Time Applications | 10 | CO1, CO2, CO5 | 14 | 4 | 6 | 6 |
| Total | 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. | Verification of the features of 8085 Trainer Kit | CO1 | 40 | 50 | 10 |
| 2. | ALP based on Data transfer Instructions & Arithmetic Instructions(addition) in 8085 | CO1 | 50 | 40 | 10 |
| 3. | ALP based on Data transfer Instructions and arithmetic Instructions(subtraction) in 8085 | CO1 | 50 | 40 | 10 |
| 4. | Verification of the features of 8051 Trainer Kit | CO1, CO2 | 40 | 50 | 10 |
| 5. | ALP based on Data transfer Instructions & Arithmetic Instructions(addition) in 8051 | CO3, CO4 | 50 | 40 | 10 |
| 6. | ALP based on Data transfer Instructions and arithmetic Instructions(subtraction) in 8051 | CO3, CO4 | 50 | 40 | 10 |
| 7. | Write an ALP to generate delay using Timer | CO3, CO4 | 50 | 40 | 10 |
| 8. | Interfacing 7 segment display with 8051 | CO3, CO4, CO5 | 60 | 30 | 10 |
| 9. | Interfacing a DC Motor with 8051. | CO3, CO4, CO5 | 60 | 30 | 10 |

| | | | | | |
|-----|---------------------------------------|---------------|----|----|----|
| 10. | Interfacing a Stepper Motor with 8051 | CO3, CO4, CO5 | 60 | 30 | 10 |
| 11. | Interfacing 8-bit DAC with 8051 | CO3, CO4, CO5 | 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 | Broad Specifications | Relevant Experiment Number |
|--------|---|---|----------------------------|
| 1 | Microcontroller Trainer kit | Single board systems with 8K RAM, ROM memory with battery backup, 16X4,16 X2, LCD display, PC keyboard interfacing facility, Hex keypad facility, single user cross c-compiler, RS- 232, USB, interfacing facility with built in power supply | All |
| 2 | PC with microcontroller simulation software | Desktop PC (above I5& 16GB RAM) with microcontroller simulation software | All |
| 3 | CRO/DSO | Bandwidth AC 10Hz ~ 20MHz (-3dB). DC~ 20MHz (-3dB), X10 Probe | All |
| 4 | Stepper Motor | 50/100 RPM | 10 |
| 5 | Trainer board | Keyboard 4*4 trainer board | 7 -11 |
| 6 | 7-segment LED Display | 7-segment LED Display: - 0.56 in 1-digit, common anode/common cathode | 8 |
| 7 | Multimeter | Digital | 8 -11 |
| 8 | Trainer board | ADC (0808) trainer board | 11 |
| 9 | Trainer board | DAC (0808) trainer board | 11 |
| 10 | Trainer board | LCD trainer board | 8 |
| 11 | Sensors | LM35, ADXL345, AD590, BMP085, DT11, NTC, IIS3DWBTR, etc. | 7 |

R) Suggested Learning Resources:**(a) Books:**

| S. No. | Titles | Author(s) | Publisher and Edition with ISBN |
|--------|--|---|--|
| 1. | Microprocessor Architecture, Programming, and Applications with the 8085 | Ramesh S. Gaonkar | Penram International Publishing (India) Private Limited, 5th Edition ISBN: 978-8187972099 |
| 2. | 8051 Microcontroller Architecture Programming and Application | Kenneth J. Ayala | EEE/Prentice Hall of India, 2nd edition ISBN: 978-1401861582 |
| 3. | The 8051 Microcontroller and Embedded systems using Assembly and C | Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinley | Pearson/Prentice Hall, 2nd edition, ISBN: 978-8177589030 |
| 4. | Microcontroller Principle and Application | Ajit Pal | Prentice Hall, India, New Delhi, 2014, ISBN: 978-8120343924 |
| 5. | Microcontroller Theory and Application | Ajay Deshmukh | Tata McGraw Hill Pvt. Ltd., New Delhi, 2011, ISBN- 978-0070585959 |
| 6 | Microcontroller Architecture Programming, Interfacing and System Design | Raj Kamal | Pearson Education India, ISBN13:978-8131759905 |

(b) Online Educational Resources:

1. Simulation software: www.keil.com
2. Simulation software: www.edsim51.com
3. Presentation: www.slideshare.net/aismahesh/memory-8051
4. Microcontroller: www.binaryupdates.com/switch-with-8051-microcontroller/
5. Microcontroller: <https://www.8051projects.net/download-c4-8051-projects.html>

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational resources before use by the students.

- A) **Course Code** : 2443403(T2443403/P2443403/S2443403)
 B) **Course Title** : Hydraulic and Pneumatic Controls
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

Hydraulic and pneumatic operated machines and equipment are widely used in various mechanical and process industries due to its versatility and adaptability to automation. Engineering workforce in such industries are required to maintain hydraulic and pneumatic systems in different segments of industries. This competency needs the knowledge and basic skills related with construction and working of different components of such systems. This course will give the students, the basic skills and knowledge to use and maintain different types of hydraulic systems and pneumatic systems.

- 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** Analyze the various parameters of pneumatic and hydraulic systems
CO-2 Select pump and actuators for the given system.
CO-3 Select relevant control valves and sensors for the given system
CO-4 Select relevant compressor and relevant components and accessories for the given system
CO-5 Design hydraulic and pneumatic circuits for the given application.
CO-6 Design electro - pneumatic and electro- hydraulic circuits for the given application.

- 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 | 2 | 2 | - | 1 | | |
| CO-2 | 3 | 2 | 1 | 2 | 2 | - | 1 | | |
| CO-3 | 3 | 2 | 1 | 2 | 2 | - | 1 | | |
| CO-4 | 3 | 2 | 1 | 2 | 2 | - | 1 | | |
| CO-5 | 3 | 2 | 2 | 2 | 2 | - | 1 | | |
| CO-6 | 3 | 2 | 2 | 2 | 2 | - | 1 | | |

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 | | | | |
| Mechanical Engineering | 2443403 | Hydraulic and Pneumatic Controls | 03 | - | 04 | 02 | 09 | 06 |

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) | |
| Mechanical Engineering | 2443403 | Hydraulic and Pneumatic Controls | 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:

- 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: T2443403**

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|--|--|------------------------|
| <p><i>TSO 1a.</i> Describe various laws governing fluid flow.</p> <p><i>TSO 1b.</i> Differentiate between aerostatic, hydrostatic, and hydrodynamic support</p> <p><i>TSO 1c.</i> Describe the cause of pressure drop and its effect</p> <p><i>TSO 1d.</i> Explain the properties of the given hydraulic oil.</p> <p><i>TSO 1e.</i> Identify the purpose of components on a given diagram</p> <p><i>TSO 1f.</i> Analyze the effect of temperature, pressure on hydraulic oil performance</p> <p><i>TSO 1g.</i> Select the hydraulic fluid for the given application.</p> <p><i>TSO 1h.</i> Describe the factors affecting hydraulic oil contamination</p> <p><i>TSO 1i.</i> Draw the ISO symbols for the given hydraulic and pneumatic components</p> <p><i>TSO 1j.</i> List safety precautions required for handling industrial hydraulics and pneumatics systems.</p> <p><i>TSO 1k.</i> Identify the Hazards in using given hydraulic and pneumatic systems</p> <p><i>TSO 1l.</i> Describe ISO symbols and guiding rules for designing hydraulic and pneumatic system.</p> <p><i>TSO 1m.</i> Calculate the parameters of pneumatic and hydraulic systems</p> | <p>Unit-1.0 Introduction to Hydraulic and Pneumatic Systems</p> <p>1.1 Fluid power- history, concept and Definition, Fluid transport systems, Fluid power systems</p> <p>1.2 Classification of Fluid Power Systems- Based on the control system, Based on the type of control</p> <p>1.3 Concept of Hydrostatic and hydrodynamic</p> <p>1.4 Laws governing fluid flow- Pascal's law, Continuity equation, Bernoulli's theorem</p> <p>1.5 Flow through pipes-types, pressure drop in pipes.</p> <p>1.6 Hydraulic fluid - types ISO and SAE grades of oil and designations, properties, oil contamination and their advantages and limitations.</p> <p>1.7 General layout of hydraulic and pneumatic systems and components</p> <p>1.8 ISO Symbols used in Hydraulic, Pneumatic system.</p> <p>1.9 Applications, merits, limitations</p> <p>1.10 Hazard and safety in industrial hydraulics and pneumatics.</p> | <p>CO1</p> |
| <p><i>TSO 2a.</i> Classify the given types of pumps</p> <p><i>TSO 2b.</i> Compare given two types of pumps on the basis of the given criteria.</p> <p><i>TSO 2c.</i> Select relevant pump for the given application with justification.</p> <p><i>TSO 2d.</i> Compare the given actuators with respect to identified criteria.</p> <p><i>TSO 2e.</i> Assess the different factors that impact on actuator choice for a given application</p> <p><i>TSO 2f.</i> Describe with sketches the construction and working of the given actuators.</p> | <p>Unit-2.0 Pumps and Actuators</p> <p>2.1 Classification of pumps.</p> <p>2.2 Construction and working of gear, vane, screw, lobe and piston pumps (axial and radial)</p> <p>2.3 Performance characteristics, specifications and selection criteria of pumps.</p> <p>2.4 Classification of hydraulic and pneumatic actuators.</p> <p>2.5 Construction and working of linear actuators – single acting and double acting cylinders, Cylinder –cushioning, stop tube</p> | <p>CO2</p> |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|--|------------------------|
| <p><i>TSO 2g.</i> Select the relevant actuators for the given application with justification.</p> <p><i>TSO 2h.</i> Identify the faults in the given pump and suggest the remedies</p> <p><i>TSO 2i.</i> Explain routine maintenance procedure of the pump and actuator</p> <p><i>TSO 2j.</i> Troubleshoot the given hydraulic system</p> <p><i>TSO 2k.</i> Calculate pump efficiency and Brake Horse Power (BHP) of the pump</p> | <p>2.6 Construction and working of rotary actuators (rotary Motors)-. Gear motors, Vane motors, Axial - in-line - swash plate piston motors,</p> <p>2.7 Specifications and selection criteria of actuators</p> <p>2.8 Maintain pumps and actuators</p> | |
| <p><i>TSO.3a</i> Classify the given types of control valves with respect to identified criteria.</p> <p><i>TSO.3b</i> Describe with sketches the construction and working of the given valves.</p> <p><i>TSO.3c</i> Describe the actuation method of the given valves for the given application.</p> <p><i>TSO.3d</i> Select relevant control valve for the given application with the justification.</p> <p><i>TSO.3e</i> Use control valves as per the requirement.</p> <p><i>TSO.3f</i> Differentiate between proportional and servo valve.</p> | <p>Unit-3.0 Control Valves and Sensors</p> <p>3.1 Classification of control valves,</p> <p>3.2 Pressure control valves-relief, unloading, sequence, counter balance, pressure reducing valves.</p> <p>3.3 Direction control valves- check valves, 2/2, 3/2, 4/2, 4/3, 5/2, 5/3 D.C. Valves used in hydraulics and pneumatics.</p> <p>3.4 Standard centre positions, methods of actuation, Types of valve element</p> <p>3.5 Servo valves, pressure control valves</p> <p>3.6 Flow control valves – Non- compensated, Pressure and temperature compensated.</p> <p>Hydraulic and Pneumatic Sensors</p> <p>3.7 Introduction to hydraulic and pneumatic sensors</p> <p>3.8 Types of hydraulic and pneumatic sensors- Pressure and temperature monitoring sensors, hydraulic flow rate sensor, level sensor, Pneumatic Proximity Sensors, Back Pressure Sensor (Pilot tube), Reflex Sensor (Screen Nozzle) Air Barrier Sensor, Pneumatic-electric transducers</p> <p>3.9 Unique features of Pneumatic and Hydraulic sensor</p> | CO3 |
| <p><i>TSO 4a.</i> Describe the function and working of the given compressor</p> <p><i>TSO 4b.</i> Select the relevant compressor for the given application with justification.</p> <p><i>TSO 4c.</i> Identify various accessories used in the given hydraulic /pneumatics systems</p> <p><i>TSO 4d.</i> Select the relevant accessories for the given type of hydraulic /pneumatic system with justification.</p> <p><i>TSO 4e.</i> Select appropriate hydraulic and pneumatic pipe for given application</p> <p><i>TSO 4f.</i> Use and maintain FRL unit in pneumatics</p> <p><i>TSO 4g.</i> Select hydraulic and pneumatic accessories with its location on hydraulic and pneumatic system.</p> | <p>Unit-4.0 Compressor, Components and Accessories</p> <p>4.1 Pneumatic Control System-Introduction, Air Preparation-Primary and Secondary Air Treatment</p> <p>4.2 Pneumatic Power Source- Compressor, Classification, Air Receiver and Control Methods</p> <p>4.3 Compressors-Types, construction, working principle of Reciprocating Type Air Compressor-Single and Multi-stage Piston Pump, Rotary compressors. PV Diagram and Work Done</p> <p>4.4 Construction, working principle of FRL unit, Dual (twin) pressure valve, shuttle valve, Quick exhaust valve, Time delay valve.</p> <p>4.5 Accessories: Oil reservoir, pipes, hoses, fittings, oil filters, air filters, seals and gaskets,</p> | CO4 |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|---|------------------------|
| <p><i>TSO 4h.</i> Calculate mechanical efficiency, volumetric efficiency and isothermal efficiency of the compressor.</p> | <p>intensifiers, accumulators, heat exchanger, muffler, Air Dryer</p> <p>4.6 Hydraulic pipes and pneumatics pipes -Types, standards, designation methods and specifications, pressure ratings, applications and selection criteria</p> | |
| <p><i>TSO 5a.</i> Interpret given hydraulic and pneumatic circuit drawings.</p> <p><i>TSO 5b.</i> Explain with sketches the working of the given hydraulic and pneumatic circuit.</p> <p><i>TSO 5c.</i> Select the relevant components required to develop the given hydraulic and pneumatic circuit with justification.</p> <p><i>TSO 5d.</i> Analyze the given hydraulic and pneumatic circuits</p> <p><i>TSO 5e.</i> Select relevant components for the given hydraulic and pneumatic application</p> <p><i>TSO 5f.</i> Design hydraulic and pneumatic circuits for the given application</p> <p><i>TSO 5g.</i> Describe the procedure for maintaining basic hydraulic circuit pneumatic circuits based on given system requirements.</p> <p><i>TSO 5i.</i> Identify the faults in the given hydraulic system and pneumatic system and remedial measures</p> <p><i>TSO 5j.</i> Troubleshoot the given hydraulic and pneumatic system</p> <p><i>TSO 5k.</i> Use hydraulic software and pneumatic software to develop circuits</p> <p><i>TSO 5l.</i> Simulate different components hydraulic and pneumatic systems</p> | <p>Unit-5.0 Hydraulic and Pneumatic Circuits</p> <p>5.1 Basic Hydraulic Circuits – types (such as intensifier, regenerative, synchronizing, sequencing, speed components), working and applications, control, safety, circuit diagram</p> <p>5.2 Design hydraulic circuits -single and double acting hydraulic cylinders, motors, circuit for speed control Meter-in, Meter-out, Bleed Off circuit</p> <p>5.3 Design hydraulic circuit for Regenerative, synchronizing counterbalance, Sequencing circuits, two pump unloading</p> <p>5.4 Design hydraulic circuits for Milling machine, Grinding machine, Shaper machine</p> <p>Pneumatic Circuits</p> <p>5.5 Circuit diagram, components, working and applications. Design and analysis of Multiple Actuators</p> <p>5.6 Develop pneumatic Logic circuit - classic method, cascade method, step counter method, karnaugh, veitch maps and combinational circuit design</p> <p>5.7 Design pneumatic circuits for- direct /indirect control of single and double acting air cylinders, motors, two step feed control, automatic cylinder reciprocation, time delay, quick exhaust, sequencing circuits, Logic AND/OR circuits</p> <p>5.8 Design pneumatic circuits for Speed control circuit for cylinders and motors.</p> <p>5.9 Design electro-pneumatic circuits.</p> <p>5.10 Analysis of Hydraulic and Pneumatic Circuits</p> <p>5.11 Modelling and Simulation in Hydraulic and pneumatic Components</p> <p>5.12 Selection of relevant components</p> <p>5.13 Remedies and fault detection in hydraulic and pneumatic circuits, Maintenance of hydraulic and pneumatic systems.</p> | <p>CO5</p> |
| <p><i>TSO 6a.</i> Differentiate between Pneumatic servo system, Hydro-Pneumatics, Electro-Pneumatics, Electro-hydraulic systems</p> <p><i>TSO 6b.</i> Interpret given, Electro-hydraulic and Electro pneumatic circuit drawings.</p> <p><i>TSO 6c.</i> Describe Electro- pneumatic controls</p> | <p>Unit-6.0 Electro Pneumatic System and Electro Hydraulic Systems</p> <p>6.1 Introduction to Pneumatic servo system, Hydro-Pneumatics, Electro-Pneumatics, Electro-hydraulic</p> <p>6.2 Applications, Advantages and Disadvantages of above systems.</p> | <p>CO6</p> |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|--|------------------------|
| <p><i>TSO 6d.</i> Select the relevant components required to develop the given Electro -hydraulic and electro-pneumatic circuit with justification.</p> <p><i>TSO 6e.</i> Analyze the given Electro-hydraulic and Electro pneumatic circuit</p> <p><i>TSO 6f.</i> Select relevant components to for the given Electro-hydraulic and Electro pneumatic application</p> <p><i>TSO 6g.</i> Design Electro-hydraulic and Electro pneumatic circuit for the given application</p> <p><i>TSO 6h.</i> Describe the procedure for maintaining Electro-hydraulic and Electro pneumatic circuit based on given system requirements.</p> <p><i>TSO 6i.</i> Use electro-hydraulic software and electro-pneumatic software to develop circuits</p> <p><i>TSO 6j.</i> Simulate different components Electro-hydraulic and Electro pneumatic systems.</p> <p><i>TSO 6k.</i> Maintain various electro hydraulic and electro – pneumatic devices</p> | <p>6.3 Electro -pneumatic controls, operation of electric actuated valves, Pneumatic electrical transducers, Electric converters, signal processors. Relays and protection relays. Connections of direct and indirect management. Logic circuits. Time Tracking Control. Checking workflows, Proportional pneumatics. Proportional switching</p> <p>6.4 Electrohydraulic control, Hydraulic cylinders, Control of pneumatic and hydraulic processes using a PLC controller</p> <p>6.5 Basic electro pneumatic circuits, Basic electrohydraulic circuits.</p> <p>6.6 Application of hydraulic and Electro Hydraulic System - working principle, major elements, performance variables and applications of following devices-Automotive hydraulic brake, Industrial Fork lift, Hydraulic jack, Hydraulic press, Automotive power steering, Hydraulic lift, Painting booth, Rotary machining station</p> <p>6.7 Application of pneumatic and Electro pneumatic System- working principle, major elements, performance variables and applications of following devices -Allocating device, sorting device, edge folding device, Foil welding, drum, switching point device, Feed rail separator, Welding machine for thermoplastic, stone sorter, clamping camera housing, Input station for laser cutter, partial automation of an internal, grinder, Drilling machine, Pneumatic counter</p> | |

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2443403

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|---|--------|---|------------------------|
| LSO1.1 Identify components and draw ISO symbols of the components used in hydraulic and Pneumatics system | 1. | Identify the components on the given hydraulic and pneumatic systems. | CO1 |
| | 2. | Identify and draw ISO symbols used in given hydraulic and Pneumatics components | CO1 |
| LSO1.2 Use Hydrostatics and properties of fluids apparatus | 3. | Determine the effect of temperature and pressure on hydraulic oil performance | CO1 |
| | 4. | Determine the properties of the given hydraulic fluid | CO1 |
| LSO1.3 Use Bernoulli test rig | 5. | Investigate the validity of the Bernoulli equation when it is applied to a steady flow of water through a tapered duct. | CO1 |
| LSO1.4 Use Flow losses in pipe apparatus | 6. | Determine the Co-efficient of friction of flow through pipes of various sizes | CO1 |

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|--|--------|--|------------------------|
| | 7. | Determine minor losses in flow through pipes | CO1 |
| LSO2.1 Use hydraulic bench / Centrifugal pump test rig | 8. | Determine the various efficiencies of the given pump | CO2 |
| | 9. | Determine the efficiency of a given centrifugal pump and plot the following graphs. (i) I/P vs Discharge (ii) Total head vs Discharge (iii) Efficiency vs Discharge. | CO2 |
| | 10. | Determine the operational characteristics of two centrifugal pumps when they are configured as a single pump, two pumps in series, and two pumps in parallel. | CO2 |
| | 11. | Determine the various performance of the single stage centrifugal pump for constant & variable speed. | CO2 |
| | 12. | Determine the various performance of the multi stage centrifugal pump for constant & variable speed. | CO2 |
| | 13. | Determine the various performance of the reciprocating pump for (1) Variable speed and constant head (2) Constant speed and variable head | CO2 |
| | 14. | Determine the efficiency of a given gear pump and plot the following graphs i) Percentage efficiency vs head ii) Percentage slip vs head iii) Discharge vs head iv) Output vs head | CO2 |
| LSO2.2 Use DC servo motor | 15. | Determine speed-torque characteristic of D.C servomotor. | CO2 |
| LSO2.3 Use AC servo motor | 16. | Determine speed torque characteristics of AC servo motor. | CO2 |
| LSO2.4 Use stepper motor | 17. | Program the motor to operate in CCW and CW direction with user control speed | CO2 |
| | 18. | Identify of stepper motor terminals and control in wave step mode | CO2 |
| LSO2.5 Use hydraulic and pneumatic trainer | 19. | Design circuit to actuate double acting cylinder using pneumatic direction control valve | CO2 |
| | 20. | Control the direction and speed of cylinders. | CO2 |
| LSO3.1 Use Control Valve Characteristics Trainer | 21. | Determine the flow coefficient Cv of the linear control valve | CO3 |
| | 22. | Determine the flow coefficient Cv of the quick open control valve | CO3 |
| | 23. | Calculate rangeability of linear control valve | CO3 |
| | 24. | Calculate rangeability of quick open control valve. | CO3 |
| LSO3.2 Use hydraulic and pneumatic trainer | 25. | Design a circuit using direction control valve and pressure control valve for clamping device for jigs and fixture | CO3 |

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|---|--------|---|------------------------|
| LSO3.3 Use Pressure Process Control Training System | 26. | Determine the performance of ON-OFF/P/PI/PD/PID controllers on pressure process. | CO3 |
| LSO3.4 Use Level Control Trainer. | 27. | Determine the performance of ON – OFF/P/PI/PD/PID controllers on level process | CO3 |
| LSO3.5 Use Flow Control Trainer | 28. | Determine the performance of ON – OFF/P/PI/PD/PID controllers on flow process | CO3 |
| LSO3.6 Use temperature Control Trainer. | 29. | Determine the performance of ON-OFF/P/PI/PD/PID controllers on temperature process. | CO3 |
| LSO 4.1. Use compressor test rig | 30. | Determine Performance of a two stage Reciprocating Air Compressor | CO4 |
| | 31. | Determine performance of a two-stage single acting reciprocating air compressor. | CO4 |
| | 32. | Determine volumetric efficiency and isothermal efficiency of two stage single acting reciprocating air compressor. | CO4 |
| | 33. | Determine various performance of the given compressor | CO4 |
| LSO 4.2. Use hydraulic ram test rig | 34. | Determine the working characteristics of hydraulic ram at constant valve lift and constant supply head and plot the following curves. <ul style="list-style-type: none"> • Pumped water v/s Delivery head • waste water v/s Delivery head • D'aubussion efficiency v/s Delivery head • Rankines's efficiency v/s Delivery head • Number of heats/sec v/s Delivery head | CO4 |
| LSO 5.1. Use hydraulic trainer with simulation software | 35. | Design, assemble and operate hydraulic circuit to actuate and control SAC and DAC | CO5 |
| | 36. | Design, assemble and operate Meter-in, Meter out hydraulic circuit. | CO5 |
| | 37. | Design, assemble and operate any suitable sequencing hydraulic circuit | CO5 |
| | 38. | Design the hydraulic system circuit based on given input and parameters using hydraulic simulation software. | CO5 |
| | 39. | Design, assemble and operate Regenerative Circuit | CO5 |
| | 40. | Design, assemble and operate hydraulic circuit using accumulator | CO5 |
| | 41. | Develop Automatic cylinder reciprocation circuit using hydraulic trainer. | CO5 |
| LSO 5.2. Use pneumatic trainer with simulation software | 42. | Design, assemble and operate Pneumatic circuits to actuate and control SAC, DAC, Air motor | CO5 |
| | 43. | Design, assemble and operate Pneumatic circuits for controlling speed | CO5 |
| | 44. | Design, assemble and operate indirect/pilot control Pneumatic circuit | CO5 |
| | 45. | Develop any suitable sequencing Pneumatic circuit. | CO5 |

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|--|--------|--|------------------------|
| | 46. | Design, assemble and operate Pneumatic circuits for Logic functions (AND/OR/Time delay) | CO5 |
| | 47. | Develop Automatic cylinder reciprocation circuit using pneumatic trainer | CO5 |
| LSO 6.1. Use electro pneumatic trainer | 48. | Design, assemble and operate Electro Pneumatic circuits to actuate and control SAC, DAC, Air motor | CO6 |
| | 49. | Design, assemble and operate Electro Pneumatic circuits for the given application | CO6 |
| LSO 6.2. Use electro hydraulic trainer | 50. | Design, assemble and operate Electro Hydraulic circuits to actuate and control SAC, DAC, Air motor | CO6 |
| | 51. | Design, assemble and operate Electro Hydraulic circuits for the given application | CO6 |

L) **Suggested Term Work and Self Learning: S2443403** 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.

- Produce a presentation analyzing fluid viscosity using Stokes' Law and validate how this relates to Navier–Stokes equations
- Stating any assumptions, compare the applications of practical hydraulic and pneumatic systems
- Prepare report of agriculture equipment's working on hydraulics and pneumatics.
- Prepare report on working of hydraulic jack and its system.
- Analyze the methods in fluid power principles and working of hydraulic pumps

b. **Micro Projects:**

- Prepare working model of hydraulic crane using waste injections used by doctors.
- Develop working model of automation of bench vice used in carpentry/fitting shop.
- Market survey of oil used in hydraulic system (Manufacturers, specification, trade names, cost, packing size)
- Design of hydraulic / pneumatic system and related components for any industrial application

c. **Other Activities:**

1. Seminar Topics:

- Hazard and safety in industrial hydraulic and pneumatic.
- Remedies and faults detection in pneumatic and hydraulic circuits.
- Prototype working model of hydraulically operated hospital bed.
- Types of oil filters.

2. Visits: Visit nearby tool room/industry with hydraulic and pneumatic operated machines. Prepare report of visit with special comments of hydraulic and pneumatic operated machine used, material used, single component/batch production/mass production and cost of machine used.

3. Self-learning topics:

- Prepare journal based on practical performed in Industrial fluid power laboratory. Journal consist of drawing, observations, required measuring tools, equipment's etc.
- Prepare visit report of any automobile service station to observe use of pneumatic hand tools.
- Hydraulic operated crane operation.
- Visit nearby industry and learn to operate pneumatic machine.

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 | 15% | 15% | 15% | 20% | - | 20% | 15% |
| CO-2 | 15% | 15% | 15% | 20% | - | 10% | 15% |
| CO-3 | 15% | 15% | 15% | 20% | 33% | 15% | 20% |
| CO-4 | 20% | 20% | 20% | 20% | 33% | 20% | 20% |
| CO-5 | 20% | 20% | 20% | 20% | 34% | 20% | 15% |
| CO-6 | 15% | 15% | 15% | 20% | | 15% | 15% |
| 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 Introduction to Hydraulic and Pneumatic Systems | 8 | CO1 | 10 | 3 | 3 | 4 |
| Unit-2.0 Pumps and Actuators | 8 | CO2 | 10 | 3 | 2 | 5 |
| Unit-3.0 Control Valves and Sensors | 8 | CO3 | 10 | 3 | 2 | 5 |
| Unit-4.0 Compressor, Components and Accessories | 8 | CO4 | 15 | 4 | 6 | 5 |
| Unit-5.0 Hydraulic and Pneumatic Circuits | 8 | CO5 | 15 | 4 | 5 | 6 |
| Unit-6.0 Electro Pneumatic System and Electro Hydraulic Systems | 8 | CO6 | 10 | 3 | 3 | 4 |
| Total | 48 | - | 70 | 20 | 21 | 29 |

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 Experiment/Practical Titles | Relevant COs Number(s) | PLA/ELA | | |
|--------|--|------------------------|-------------|-----------|---------------|
| | | | Performance | | Viva-Voce (%) |
| | | | PRA* (%) | PDA** (%) | |
| 1. | Identify the components on the given hydraulic and pneumatic systems. | CO1 | 40 | 50 | 10 |
| 2. | Identify and draw ISO symbols used in given hydraulic and Pneumatics components | CO1 | 40 | 50 | 10 |
| 3. | Determine the effect of temperature and pressure on hydraulic oil performance | CO1 | 40 | 50 | 10 |
| 4. | Determine the properties of the given hydraulic fluid | CO1 | 40 | 50 | 10 |
| 5. | Investigate the validity of the Bernoulli equation when it is applied to a steady flow of water through a tapered duct. | CO1 | 40 | 50 | 10 |
| 6. | Determine the Co-efficient of friction of flow through pipes of various sizes | CO1 | 40 | 50 | 10 |
| 7. | Determine minor losses in flow through pipes | CO1 | 40 | 50 | 10 |
| 8. | Determine the various efficiencies of the given pump | CO2 | 40 | 50 | 10 |
| 9. | Determine the efficiency of a given centrifugal pump and plot the following graphs. (i) I/P vs Discharge (ii) Total head vs Discharge (iii) Efficiency vs Discharge. | CO2 | 40 | 50 | 10 |
| 10. | Determine the operational characteristics of two centrifugal pumps when they are configured as a single pump, two pumps in series, and two pumps in parallel. | CO2 | 40 | 50 | 10 |
| 11. | Determine the various performance of the single stage centrifugal pump for constant & variable speed. | CO2 | 40 | 50 | 10 |
| 12. | Determine the various performance of the multi stage centrifugal pump for constant & variable speed. | CO2 | 40 | 50 | 10 |
| 13. | Determine the various performance of the reciprocating pump for (1) Variable speed and constant head (2) Constant speed and variable head | CO2 | 40 | 50 | 10 |
| 14. | Determine the efficiency of a given gear pump and plot the following graphs i) Percentage efficiency vs head ii) Percentage slip vs head iii) Discharge vs head iv) Output vs head | CO2 | 40 | 50 | 10 |
| 15. | Determine speed-torque characteristic of D.C servomotor. | CO2 | 40 | 50 | 10 |
| 16. | Determine speed torque characteristics of AC servo motor. | CO2 | 40 | 50 | 10 |
| 17. | Program the motor to operate in CCW and CW direction with user control speed | CO2 | 40 | 50 | 10 |
| 18. | Identify of stepper motor terminals and control in wave step mode | CO2 | 40 | 50 | 10 |
| 19. | Design circuit to actuate double acting cylinder using pneumatic direction control valve | CO2 | 40 | 50 | 10 |

| S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) | PLA/ELA | | |
|--------|--|------------------------|-------------|-----------|---------------|
| | | | Performance | | Viva-Voce (%) |
| | | | PRA* (%) | PDA** (%) | |
| 20. | Control the direction and speed of cylinders. | CO2 | 40 | 50 | 10 |
| 21. | Determine the flow coefficient Cv of the linear control valve | CO3 | 40 | 50 | 10 |
| 22. | Determine the flow coefficient Cv of the quick open control valve | CO3 | 40 | 50 | 10 |
| 23. | Calculate rangeability of linear control valve | CO3 | 40 | 50 | 10 |
| 24. | Calculate rangeability of quick open control valve. | CO3 | 40 | 50 | 10 |
| 25. | Design a circuit using direction control valve and pressure control valve for clamping device for jigs and fixture | CO3 | 40 | 50 | 10 |
| 26. | Determine the performance of ON-OFF/P/PI/PD/PID controllers on pressure process. | CO3 | 40 | 50 | 10 |
| 27. | Determine the performance of ON –OFF/P/PI/PD/PID controllers on level process | CO3 | 40 | 50 | 10 |
| 28. | Determine the performance of ON –OFF/P/PI/PD/PID controllers on flow process | CO3 | 40 | 50 | 10 |
| 29. | Determine the performance of ON-OFF/P/PI/PD/PID controllers on temperature process. | CO3 | 40 | 50 | 10 |
| 30. | Determine Performance of a two stage Reciprocating Air Compressor | CO4 | 40 | 50 | 10 |
| 31. | Determine performance of a two-stage single acting reciprocating air compressor. | CO4 | 40 | 50 | 10 |
| 32. | Determine volumetric efficiency and isothermal efficiency of two stage single acting reciprocating air compressor. | CO4 | 40 | 50 | 10 |
| 33. | Determine various performance of the given compressor | CO4 | 40 | 50 | 10 |
| 34. | Determine the working characteristics of hydraulic ram at constant valve lift and constant supply head and plot the following curves. <ul style="list-style-type: none"> • Pumped water v/s Delivery head • waste water v/s Delivery head • D' aubussion efficiency v/s Delivery head • Rankines's efficiency v/s Delivery head • Number of heats/sec v/s Delivery head | CO4 | 40 | 50 | 10 |
| 35. | Design, assemble and operate hydraulic circuit to actuate and control SAC and DAC | CO5 | 40 | 50 | 10 |
| 36. | Design, assemble and operate Meter-in, Meter out hydraulic circuit. | CO5 | 40 | 50 | 10 |
| 37. | Design, assemble and operate any suitable sequencing hydraulic circuit | CO5 | 40 | 50 | 10 |
| 38. | Design the hydraulic system circuit based on given input and parameters using hydraulic simulation software. | CO5 | 40 | 50 | 10 |
| 39. | Design, assemble and operate Regenerative Circuit | CO5 | 40 | 50 | 10 |

| S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) | PLA/ELA | | |
|--------|--|------------------------|-------------|-----------|---------------|
| | | | Performance | | Viva-Voce (%) |
| | | | PRA* (%) | PDA** (%) | |
| 40. | Design, assemble and operate hydraulic circuit using accumulator | CO5 | 40 | 50 | 10 |
| 41. | Develop Automatic cylinder reciprocation circuit using hydraulic trainer. | CO5 | 40 | 50 | 10 |
| 42. | Design, assemble and operate Pneumatic circuits to actuate and control SAC, DAC, Air motor | CO5 | 40 | 50 | 10 |
| 43. | Design, assemble and operate Pneumatic circuits for controlling speed | CO5 | 40 | 50 | 10 |
| 44. | Design, assemble and operate indirect/pilot control Pneumatic circuit | CO5 | 40 | 50 | 10 |
| 45. | Develop any suitable sequencing Pneumatic circuit. | CO5 | 40 | 50 | 10 |
| 46. | Design, assemble and operate Pneumatic circuits for Logic functions (AND/OR/Time delay) | CO5 | 40 | 50 | 10 |
| 47. | Develop Automatic cylinder reciprocation circuit using pneumatic trainer | CO5 | 40 | 50 | 10 |
| 48. | Design, assemble and operate Electro Pneumatic circuits to actuate and control SAC, DAC, Air motor | CO6 | 40 | 50 | 10 |
| 49. | Design, assemble and operate Electro Pneumatic circuits for the given application | CO6 | 40 | 50 | 10 |
| 50. | Design, assemble and operate Electro Hydraulic circuits to actuate and control SAC, DAC, Air motor | CO6 | 40 | 50 | 10 |
| 51. | Design, assemble and operate Electro Hydraulic circuits for the given application | CO6 | 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. | Hydrostatics and properties of fluids apparatus | Self-contained apparatus for many experiments in fluid mechanics and properties of fluids, hydrostatic principles and buoyancy / floatation and Archimedes' principle. | 3,4 |

| S. No. | Name of Equipment, Tools and Software | Broad Specifications | Relevant Experiment/Practical Number |
|--------|---|--|--------------------------------------|
| 2. | Bernoulli test rig | Take tank 2/3 full of water, floating vessel or pontoon fitted with a pointed pointer moving on a graduated scale, with weights adjusted on a horizontal beam | 5 |
| 3. | Flow losses in pipe apparatus | Flow losses in pipe apparatus with flow control device and manometer, valve fitted with each pipe to Regulate the flow, a measuring tank fitted with a piezometer tube and a graduated scale, Stop watch, arrangement for uniform supply of water, pipe fittings consisting of sudden enlargement, sudden contraction, elbow and bend, measuring tank with a piezometer and a scale, manometer | 6,7 |
| 4. | Cut section of different types of pump and working models of pump | Working/actual models of pumps, valves, cylinders, motors, accumulators, filters etc. Cut section of pumps, valves, cylinders, motors, accumulators, filters etc. | 8-14 |
| 5. | Hydraulic bench / Centrifugal pump test rig | fitted with a single centrifugal pump that is driven by a single-phase A.C. motor, speed control unit, auxiliary pump, Pressure gauges installed at the inlet and outlet of the pumps, watt-meter unit, vacuum gauges, Flow measuring unit | 8-14 |
| 6. | DC servo motor | DC servo motor | 15 |
| 7. | AC servo motor | AC servo motor | 16 |
| 8. | Stepper motor | Stepper motor | 17-18 |
| 9. | SAC and DAC cylinders actuators | SAC and DAC cylinders actuators | 19-20 |
| 10. | Working models of different types of control valves. | Working models of different types of control valves. | 21-24 |
| 11. | Control Valve Characteristics Trainer | Mounting of different types of control valves of different design | 21-24 |
| 12. | Pressure Process Control Training System | Pressure Process Control Training System for laboratory purpose | 25-26 |
| 13. | Computerized Level Control Trainer | Computerized Level Control Trainer for laboratory purpose | 27 |
| 14. | Computer Controlled Flow Control Trainer | Computer Controlled Flow Control Trainer | 28 |
| 15. | Temperature Process Control trainer | Temperature Process Control trainer | 29 |
| 16. | Compressor test rig | Single/multistage reciprocating compressor (pressure 0-10 bar) | 30-33 |
| 17. | Hydraulic ram test rig | hydraulic ram connect to the supply tank using supply pipes, pressure gauge to measure delivery pressure, arrangement for, measuring the waste water, arrangement for measuring the perfect water, stop watch, Graph | 34 |
| 18. | Hydraulic trainer with simulation software | Hydraulic trainer with transparent/actual working components. | 19,20, 25 35-41 |
| 19. | Pneumatic trainer with simulation software | Pneumatic trainer with transparent/actual working components. | 19,20, 25, 42-47 |

| S. No. | Name of Equipment, Tools and Software | Broad Specifications | Relevant Experiment/Practical Number |
|--------|--|--|--------------------------------------|
| 20. | Electro pneumatic trainer with simulation software | Electro pneumatic trainer with transparent/actual working components | 48-49 |
| 21. | Electro hydraulic trainer with simulation software | Electro hydraulic trainer with transparent/actual working components | 50-51 |

R) Suggested Learning Resources:

(a) Books:

| S. No. | Titles | Author(s) | Publisher and Edition with ISBN |
|--------|---|---|--|
| 1. | Design Concepts in Pneumatic Systems | Joji Parambath | Kindle Edition, 2023 ASIN : B0C7PMFKRL |
| 2. | Work on hydraulic systems: components and applications of hydraulic | James Johnson | Kindle Edition, 2023 ASIN : B09V3M6TBL |
| 3. | Fundamentals of Pneumatics and Hydraulics | Md. Abdus Salam | Springer Nature; 1st ed. 2022 ISBN-10 : 9811908540 ISBN-13 : 978-9811908545 |
| 4. | Elements of Hydrostatics Hydraulics and pneumatics (Hindi Paperback) | Navina Chandra Rai | Legare Street Press, Hindi Edition, 2022 ISBN-10: 1017960445 ISBN-13: 978-1017960440 |
| 5. | Design of Pneumatic Systems | Joji Parambath | Independently Published, 2020 ISBN-13: 979-8653408809 ASIN: B08BF7NYP1 |
| 6. | Hydraulic and Pneumatic Controls 3e | Srinivasan R. | Vijay Nicole Imprints, 2019 ISBN-10: 8182095786 ISBN-13: 978-8182095786 |
| 7. | A Textbook of Fluid Mechanics and Hydraulic Machines | Dr. R. K. Bansal | LAXMI PUBLICATION, 11 th ed. 2023 ISBN-10: 8131808157 ISBN-13: 978-8131808153 |
| 8. | Modular Approach to Designing Pneumatic-Hydraulic Wellhead Control System | Subrata Chatterjee | Book Rivers, 2023 ISBN-10: 9355158416 ISBN-13: 978-9355158413 |
| 9. | Pneumatic Systems-Principles and Maintenance | S. R. Majumdar | McGraw-Hill Education, 2017 ISBN:9780074602317 |
| 10. | Hydraulics and Pneumatics | Vinayak V. Gaikwad Dr. Vikas v. Shinde | Technical Publications, 2020 ISBN:9789333219112 |

(b) Online Educational Resources:

- 1) <https://www.google.com/search?q=hydraulic+and+pneumatic+control&oq=hydraulic+and+pneumatic+control&aqs=chrome..69i57j69i61l2j69i60.23552j0j4&sourceid=chrome>
- 2) <https://archive.nptel.ac.in/courses/112/106/112106300/>
- 3) <https://pc-coep.vlabs.ac.in/exp/direct-single-acting-cylinder/theory.html>

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational recourses before use by the students.

- A) **Course Code** : 2418305(T2418305/ P2418305/S2418305)
- B) **Course Title** : Python Programming
(CE, CSE, AIML, ME, ME (Auto), ELX, ELX (R), MIE, FTS, CRE, CHE, TE, CACDDM, GT, RE)
- C) **Pre- requisite Course(s)** :
- D) **Rationale** :

Python programming has emerged as a popular programming language across wide range of application segments from Scientific to Machine Learning to mobile app development, and so on. Python is a high-level general-purpose programming language.

Because code is automatically compiled to byte code and executed, Python is suitable as a scripting language, Web application implementation language, etc.

In Python there are multiple levels of organizational structure: functions, classes, modules, and packages. These assist in organizing code. An excellent and large example is the Python standard library.

The Object-oriented Python provides a consistent way to use objects: in Python it is easy to implement new object types (called classes in object-oriented programming).

This introductory course to learn basic Python programming features which can be used as building blocks to develop different kind of applications using Python 3.

- 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 various data types and operators in formation of expressions.
- CO-2** Write and execute programs using control statements.
- CO-3** Perform relevant operations on Sequence data types
- CO-4** Create functions in modules
- CO-5** Use numpy in writing python programs
- CO-6** Handle data files and exceptions.

- 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 | 1 | - | 1 | - | - | - | - | | |
| CO-2 | 1 | 2 | 2 | 1 | - | 1 | - | | |
| CO-3 | 1 | 2 | 2 | 1 | - | 1 | - | | |
| CO-4 | 1 | 2 | 2 | 1 | - | 1 | 2 | | |
| CO-5 | 1 | 2 | 2 | 1 | - | 1 | - | | |
| CO-6 | 1 | 2 | 2 | 1 | - | 1 | 1 | | |

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) | | | | | Total Credits (C) |
|----------------|----------------|--------------------|------------------------------|---|----------------------|-------------------------|---------------------------|-------------------|
| | | | Classroom Instruction (CI) | | Lab Instruction (LI) | Notional Hours (TW+ SL) | Total Hours (CI+LI+TW+SL) | |
| | | | L | T | | | | |
| | 2418305 | Python programming | 03 | - | 04 | 02 | 09 | 06 |

Note: Prefix will be added to Course Code if applicable (T for theory Paper, P for Practical Paper and S for Term work)

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) | |
| | 2418305 | Python programming | 30 | 70 | 20 | 30 | 20 | 30 | 200 |

Note: Prefix will be added to Course Code if applicable (T for theory Paper, P for Practical Paper and S for Term work)

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:

- 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: T2418305**

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|--|--|------------------------|
| <p><i>TSO 1a.</i> Differentiate between Procedure Oriented P and Object Oriented Programming approach with example.</p> <p><i>TSO 1b.</i> Use the concept of Lvalue and Rvalue</p> <p><i>TSO 1c.</i> Write python program using various data types and operators</p> | <p>Unit 1: Fundamentals of Python Programming Syntax</p> <p>1.1 Introduction to Python Character Set, Python Tokens, Variables, Lvalue and Rvalue Concepts, and the Use of Comments.</p> <p>1.2 Overview of Data Types:</p> <ul style="list-style-type: none"> • Number Types: Integer, Floating Point, Complex • Boolean Type • Sequence Types: String, List, Tuple • None Type • Mapping Type: Dictionary • Distinction between Mutable and Immutable Data Types <p>1.3 Understanding Operators:</p> <ul style="list-style-type: none"> • Arithmetic Operators • Relational Operators • Logical Operators • Assignment Operator • Augmented Assignment Operators • Expressions and Statements • Type Conversion and Input/Output Mechanisms • Precedence of Operators • Expression Evaluation | CO-1 |
| <p><i>TSO 2a.</i> Write Python program using decision making statements</p> <p><i>TSO 2b.</i> Write Python program using loop structure to solve iterative problems</p> | <p>Unit-2.0 Conditional and Iterative statements</p> <p>2.1 Conditional statements:</p> <ul style="list-style-type: none"> • simple if statement • if- else statemen • if-elif-else statement <p>2.2 Iterative statements:</p> <ul style="list-style-type: none"> • while loop • for loop • range function • break and continue statements • nested loops | CO-2 |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|--|------------------------|
| <p><i>TSO 3a.</i> Perform various operations on string using string operators and methods</p> <p><i>TSO 3b.</i> Perform various operations on List using list operators and methods</p> <p><i>TSO 3c.</i> Perform various operations on tuples using tuples operators and methods</p> <p><i>TSO 3d.</i> Perform various operations on set using set methods</p> <p><i>TSO 3e.</i> Perform various operations on dictionary using dictionary methods</p> | <p>Unit-3.0 String, List, Tuples, set and Dictionary</p> <p>3.1 String:</p> <ul style="list-style-type: none"> • Indexing • string operations (concatenation, repetition, membership & slicing) • traversing a string using loops • built-in functions. <p>3.2 Lists:</p> <ul style="list-style-type: none"> • Introduction • Indexing in list • list operations: concatenation, repetition, membership & slicing, traversing a list, built- in list functions, linear search on list of numbers and counting the frequency of elements in a list <p>3.3 Tuples: Creating, initializing, accessing elements, tuple assignment, performing operations on tuples, tuple methods and built-in functions, nested tuples</p> <p>3.4 Set: Creating set, traversing, adding, removing data in set, performing set operations like join, Union intersection, difference</p> <p>3.5 Dictionary: accessing items in a dictionary using keys, mutability of dictionary: adding a new item, modifying an existing item, built-in dictionary functions.</p> | CO-3 |
| <p><i>TSO 4a.</i> Create and use user defined functions to implement modular programming approach</p> <p><i>TSO 4b.</i> Differentiate variable scope with example.</p> <p><i>TSO 4c.</i> Import and use Python modules, libraries</p> | <p>Unit-4.0 Python Functions, Modules and packages</p> <p>4.1 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, Lambda functions, returning value, scope of a variable: global scope, local scope</p> <p>4.2 Modules and Packages: Importing module using 'import' Regular Expressions, Exception Handling, PyPI Python Package Index, Pip Python package manager, Importing Libraries and Functions</p> | CO-4 |
| <p><i>TSO 5a.</i> Write simple Python programs using numpy</p> <p><i>TSO 5b.</i> Use Numpy array in python program</p> <p><i>TSO 5c.</i> Use Numpy to solve linear algebra problem.</p> | <p>Unit-5.0 Numpy</p> <p>5.1 Introduction to NumPy</p> <p>5.2 Installation of NumPy</p> <p>5.3 NumPy Arrays:</p> | CO-5 |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|---|------------------------|
| | <ul style="list-style-type: none"> • Understanding the NumPy array • The fundamental data structure in NumPy. • Creation of arrays using different methods: np.array(), np.zeros(), np.ones(), etc. • Exploring array attributes like shape, size, and dimensions. <p>5.4 Array Indexing and Slicing:</p> <ul style="list-style-type: none"> • Accessing elements and subarrays in NumPy arrays using indexing and slicing. • Demonstration of the difference between one-dimensional and multi-dimensional array indexing. <p>5.5 Array Operations:</p> <ul style="list-style-type: none"> • Performing element-wise operations on NumPy arrays. • Exploring universal functions (ufuncs) for mathematical operations. <p>5.6 Linear Algebra with NumPy:</p> <ul style="list-style-type: none"> • Introduction to linear algebra operations using NumPy. • Matrix multiplication, determinant, inverse, and solving linear equations. <p>5.7 File input and output with Numpy</p> <p>5.8 Broadcasting in Numpy</p> | |
| <p><i>TSO 6a.</i> Explain different types of Exceptions in python</p> <p><i>TSO 6b.</i> Write Python programs for exception handling in Python</p> <p><i>TSO 6c.</i> Differentiate different modes of file opening.</p> <p><i>TSO 6d.</i> Perform read, Write, Append operations in files</p> | <p>Unit 6: Exception and File Handling in Python</p> <p>6.1 Exception Handling: syntax errors, exceptions, need of exception handling, user-defined exceptions, raising exceptions, handling exceptions, catching exceptions, Try - except - else clause, Try - finally clause, recovering and continuing with finally, built-in exception classes.</p> <p>6.2 File Handling: text file and binary file, file types, open and close files, reading and writing text files, reading and writing binary files, file access modes</p> | <p>CO-6</p> |

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: P2418305

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|---|--------|--|------------------------|
| <p><i>LSO 1.1.</i> Write, execute and debug simple Python program using Integrated Development and Learning Environment (IDLE)</p> <p><i>LSO 1.2.</i> Write and execute simple 'C' program using variables, arithmetic expressions.</p> | 1. | <p>a) Download and Install IDLE.</p> <p>Write and execute Python program to-</p> <p>b) Calculate the Area of a Triangle where its three sides a, b, c are given. $s=(a+b+c)/2$, Area=square root of $s(s-a)(s-b)(s-c)$ (write program without using function)</p> <p>c) Swap Two Variables</p> <p>d) Solve quadratic equation for real numbers.</p> | CO-1 |
| <p><i>LSO 2.1.</i> Write and execute python programs using conditional statements.</p> <p><i>LSO 2.2.</i> Write and execute python programs using various types of Loop statements</p> | 2. | <p>Write and execute Python program to-</p> <p>a) Check if a Number is Positive, Negative or zero.</p> <p>b) Check whether the given year is a Leap Year.</p> <p>c) Print all Prime Numbers in an Interval.</p> <p>d) Display the multiplication Table based on the given input.</p> <p>e) Print the Fibonacci sequence.</p> <p>f) Find the Factorial of a Number.</p> | CO-2 |
| <p><i>LSO 3.1.</i> Write and execute Python program to perform various operations on string using string operators and methods</p> | 3. | <p>Write and execute Python program to-</p> <p>a) Check whether the string is Palindrome</p> <p>b) Reverse words in a given String in Python</p> <p>c) identify in a strings the name, position and counting of vowels.</p> <p>d) Count the Number of matching characters in a pair of string (set)</p> <p>e) Python program for removing i-th character from a string</p> | CO-2, CO-3 |
| <p><i>LSO 4.1.</i> Write and execute Python program to perform various operations on List using List operators and methods</p> | 4. | <p>Write and execute Python program to-</p> <p>a) find largest number in a given list without using max().</p> <p>b) find the common numbers from two lists.</p> <p>c) create a list of even numbers and another list of odd numbers from a given list.</p> <p>d) To find number of occurrences of given number without using built-in methods.</p> | CO-2, CO-3 |
| <p><i>LSO 5.1.</i> Write and execute Python program to perform various operations on Tuple using Tuple operators and methods.</p> | 5. | <p>Write and execute Python program to-</p> <p>a) find the index of an item of a tuple.</p> <p>b) find the length of a tuple.</p> <p>c) to reverse a tuple.</p> <p>d) Write a Python program to sort a list of tuple by its float element. Sample data: [('item1', '12.20'), ('item2', '15.10'), ('item3', '24.5')] Expected Output: [('item3', '24.5'), ('item2', '15.10'), ('item1', '12.20')]</p> | CO-2, CO-3 |

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|--|--------|--|------------------------|
| <p><i>LSO 6.1.</i> Write and execute Python program to perform various operations on sets using set methods.</p> | 6. | <p>Write and execute Python program to-</p> <ol style="list-style-type: none"> create an intersection of sets. create a union of sets. create set difference. check if two given sets have no elements in common. | CO-2, CO-3 |
| <p><i>LSO 7.1.</i> Write and execute Python program to perform various operations on Dictionary using Dictionary methods</p> | 7. | <p>Write and execute Python program to-</p> <ol style="list-style-type: none"> Write a Python script to concatenate two dictionaries to create a new one Write a Python script to merge two Python dictionaries. Write a Python program to combine two dictionary adding values for common keys. <code>d1 = {'a': 100, 'b': 200, 'c':300}</code> <code>d2 = {'a': 300, 'b': 200, 'd':400}</code> Sample output: <code>d({'a': 400, 'b': 400, 'd': 400, 'c': 300})</code> | CO-2, CO-3 |
| <p><i>LSO 8.1.</i> Write and execute Python program to create user defined functions and call them.</p> | 8. | <p>Write and execute Python program to-</p> <ol style="list-style-type: none"> Write a Python function for reversing a string and call it. Write a Python function for calculating compound interest and call it. Write a Python function for calculating the factorial of a number and call it to calculate $n!/r!(n-r)!$ where symbol “!” stands for factorial. | CO-2, CO-4 |
| <p><i>LSO 9.1.</i> Write and execute Python program to define a numpy array.</p> <p><i>LSO 9.2.</i> Develop and execute Python program Using various types of Numpy operation.</p> | 9. | <ol style="list-style-type: none"> Write a python program to create a Numpy array filled with all zeros Write a python program to check whether a Numpy array contains a specified row Write a python program to Remove rows in Numpy array that contains non-numeric values Write a python program to Find the number of occurrences of a sequence in a NumPy array Write a python program to Find the most frequent value in a NumPy array Write a python program to Combine a one and a two-dimensional NumPy Array Write a python program to Flatten a Matrix in Python using NumPy Write a python program to Interchange two axes of an array | CO-2, CO-5 |

| Practical/Lab Session Outcomes (LSOs) | S. No. | Laboratory Experiment/Practical Titles | Relevant COs Number(s) |
|---|--------|---|------------------------|
| <p><i>LSO 10.1.</i> Develop and execute Python program to handle various type of exceptions.</p> <p><i>LSO 10.2.</i> Develop and execute Python program to perform file operations.</p> | 10. | <p>a) Using exception handling feature such as try...except, try finally- write minimum three programs to handle following types of exceptions.</p> <ol style="list-style-type: none"> i. Type Error ii. Name Error iii. Index Error iv. Key Error v. Value Error vi. IO Error vii. Zero Division Error <p>b) Write Python program to demonstrate file operations.</p> | CO-6, CO-1, CO-2, |

Note: in addition to above listed practical, students are suggested to practice all the examples covered by the teacher during theory sessions.

L) Suggested Term Work and Self Learning: S2418305 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:

1. Create a shop billing system
2. Create income tax calculation system.
3. Develop number guessing game (random integer will be selected by the system and the user has to guess that integer in the minimum number of guesses. Maximum 5 guess allowed.)
4. Assign numbers to alphabet a-z as (1-26). User will input a word. System will convert it to a number by adding all the individual alphabets of that word.
5. Design a basic calculator program that performs arithmetic operations like addition, subtraction, multiplication, and division based on user input.
6. Any other micro-projects suggested by subject faculty on similar line.

(Students may use file and sequence data types to develop above listed applications)

c. Other Activities:

1. Seminar Topics:
 - Tkinter widgets in python
 - Python date/time module and its applications
 - wxPython and its applications

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% | 15% | 16% | 16% | 10% | 16% |
| CO-2 | 15% | 15% | 15% | 16% | 16% | 15% | 16% |
| CO-3 | 25% | 25% | 20% | 18% | 18% | 25% | 18% |
| CO-4 | 15% | 15% | 15% | 16% | 16% | 15% | 16% |
| CO-5 | 25% | 25% | 25% | 18% | 18% | 25% | 18% |
| CO-6 | 10% | 10% | 10% | 16% | 16% | 10% | 16% |
| 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 Basics of Python Programming syntax | 4 | CO-1 | 7 | 3 | 2 | 2 |
| Unit-2.0 Conditional and Iterative statements | 6 | CO-2 | 10 | 3 | 3 | 4 |
| Unit-3.0 3.0 String, List, Tuples, set and Dictionary | 12 | CO-3 | 18 | 5 | 3 | 10 |
| Unit-4.0 Python Functions, Modules and packages | 7 | CO-4 | 10 | 3 | 3 | 4 |
| Unit-5.0 Numpy | 12 | CO-5 | 18 | 4 | 5 | 9 |
| Unit-6.0 Exception and File Handling in Python | 7 | CO-6 | 7 | 2 | 2 | 3 |
| Total | 48 | - | 70 | 20 | 18 | 32 |

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. | Write and execute Python program to- a) Calculate the Area of a Triangle where its three sides a,b,c are given. $s=(a+b+c)/2$, Area=square root of $s(s-a)(s-b)(s-c)$ (write program without using function) b) Swap Two Variables c) Solve quadratic equation for real numbers. | CO-1 | 40 | 50 | 10 |
| 2. | Write and execute Python program to- a) Check if a Number is Positive, Negative or zero. b) Check whether the given year is a Leap Year. c) Print all Prime Numbers in an Interval. d) Display the multiplication Table based on the given input. e) Print the Fibonacci sequence. f) Find the Factorial of a Number. | CO-2 | 40 | 50 | 10 |
| 3. | Write and execute Python program to- a) Check whether the string is Palindrome b) Reverse words in a given String in Python c) identify in a strings the name, position and counting of vowels. d) Count the Number of matching characters in a pair of string (set) e) Python program for removing i-th character from a string | CO-2, CO3 | 40 | 50 | 10 |
| 4. | Write and execute Python program to- a) find largest number in a given list without using max(). b) find the common numbers from two lists. c) create a list of even numbers and another list of odd numbers from a given list. d) To find number of occurrences of given number without using built-in methods. | CO-2, CO-3 | 40 | 50 | 10 |
| 5. | Write and execute Python program to- a) find the index of an item of a tuple. b) find the length of a tuple. c) to reverse a tuple. d) Write a Python program to sort a list of tuple by its float element. Sample data: [('item1', '12.20'), ('item2', '15.10'), ('item3', '24.5')] Expected Output: [('item3', '24.5'), ('item2', '15.10'), ('item1', '12.20')] | CO-2, CO-3 | 40 | 50 | 10 |
| 6. | Write and execute Python program to- a) create an intersection of sets. b) create a union of sets. c) create set difference. d) check if two given sets have no elements in common. | CO-2, CO-3 | 40 | 50 | 10 |
| 7. | Write and execute Python program to- | CO-2, CO-3 | 40 | 50 | 10 |

| S. No. | Laboratory Practical Titles | Relevant COs Number(s) | PLA/ELA | | |
|--------|---|------------------------|-------------|-----------|---------------|
| | | | Performance | | Viva-Voce (%) |
| | | | PRA* (%) | PDA** (%) | |
| | a) Write a Python script to concatenate two dictionaries to create a new one b) Write a Python script to merge two Python dictionaries. c) Write a Python program to combine two dictionary adding values for common keys. $d1 = \{ 'a': 100, 'b': 200, 'c': 300 \}$ $d2 = \{ 'a': 300, 'b': 200, 'd': 400 \}$ Sample output: $d(\{ 'a': 400, 'b': 400, 'd': 400, 'c': 300 \})$ | | | | |
| 8. | Write and execute Python program to- a) Write a Python function for reversing a string and call it. b) Write a Python function for calculating compound interest and call it. c) Write a Python function for calculating the factorial of a number and call it to calculate $n/(!r)*!(n-r)$ where symbol "!" stands for factorial. | CO-2, CO-4 | 40 | 50 | 10 |
| 9. | a) Write a python program to create a Numpy array filled with all zeros b) Write a python program to check whether a Numpy array contains a specified row c) Write a python program to Remove rows in Numpy array that contains non-numeric values d) Write a python program to Find the number of occurrences of a sequence in a NumPy array e) Write a python program to Find the most frequent value in a NumPy array f) Write a python program to Combine a one and a two-dimensional NumPy Array g) Write a python program to Flatten a Matrix in Python using NumPy Write a python program to Interchange two axes of an array | CO-2, CO-5 | 40 | 50 | 10 |
| h) | Using exception handling feature such as try...except, try finally-write minimum three programs to handle following types of exceptions. viii. TypeError ix. NameError x. IndexError xi. KeyError xii. ValueError xiii. IOError xiv. ZeroDivisionError | CO-2, CO-6 | 40 | 50 | 10 |
| i) | Write and execute Python program to- a) Calculate the Area of a Triangle where its three sides a,b,c are given. $s=(a+b+c)/2$, Area=square root of $s(s-a)(s-b)(s-c)$ (write program without using function) b) Swap Two Variables c) Solve quadratic equation for real numbers. | CO-1 | 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. | Computer system | Processor Intel Core i5, 4 GB RAM, 15 GB free disk space | All |
| 2. | Integrated Development and Learning Environment (IDLE) | S/w to be downloaded for python 3.11.3 or higher | All |

R) Suggested Learning Resources:

(a) Books:

| S. No. | Titles | Author(s) | Publisher and Edition with ISBN |
|--------|--|---|---|
| 1. | Introduction to Computing and Problem-Solving using Python | E. Balagurusamy | McGraw Hill Education (India) Pvt. Ltd. 1 st Edition /2016 |
| 2. | Learning Python Programming | Jeffrey Elkner, Allan B. Downey, Chris Meyers | Samurai Media Limited. 2016 |
| 3. | Python Programming | Ashok Namdev Kamthane and Amit Ashok Kamthane | McGraw Hill Education (India) Pvt. Ltd. 2020, 2 nd Edition |
| 4. | Programming in Python | Dr. Pooja Sharma | BPB Publications 2017 |

(b) Online Educational Resources:

1. <https://docs.python.org/3/tutorial/>
2. <https://www.w3schools.com/python/>
3. <https://www.tutorialspoint.com/python/index.htm>

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational resources before use by the students.

- A) **Course Code** : 2425406(T2425406/S2425406)
 B) **Course Title** : Mechanics of Materials
 C) **Pre- requisite Course(s)** : Engineering Mechanics
 D) **Rationale**

The effects due to force system have already been studied in Engineering Mechanics course. All mechanical engineering components/members are subjected to different loading conditions that results in different types of stresses. In this course for Diploma in Electronic (Robotics), estimation of induced stresses, strains and strain energy of determinate structures/components under action of these transverse, axial, thermal and shear loading along with bending and torsion moment are performed. Also, this course will develop foundation for analysis and design of robotic elements going to be discussed in further semesters.

- 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** Determine direct stresses and strains in the given machine members/components.
CO-2 Calculate shear force and bending moment values along with diagrams in different types of beams/components subjected to transverse loading.
CO-3 Calculate bending stress in beams also slope and deflection in cantilever and simply supported beams/components subjected to transverse loading.
CO-4 Estimate shear stresses in shafts subjected to twisting moment.
CO-5 Select springs for given situations based on stiffness and deflection.
CO-6 Determine buckling load in column and strut for a given slenderness ratio.

- 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 | 2 | 3 | 3 | 1 | 1 | 1 | 3 | | |
| CO-2 | 3 | 3 | 2 | 1 | 1 | 1 | 3 | | |
| CO-3 | 3 | 3 | 2 | 1 | 1 | 1 | 3 | | |
| CO-4 | 3 | 3 | 2 | 2 | 1 | 1 | 3 | | |
| CO-5 | 3 | 3 | 2 | 1 | 1 | 1 | 2 | | |
| CO-6 | 3 | 3 | 2 | 1 | 1 | 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 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 | | | | |
| Electronics (Robotics) Engineering | 2425406 | Mechanics of Materials | 03 | - | - | 02 | 05 | 04 |

Legend:

CI: Classroom Instruction (Includes different instructional/implementation strategies i.e., Lecture (L), Tutorial (T), Casemethod, 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) | |
| Electronic (Robotics) Engineering | 2425406 | Mechanics of Materials | 30 | 70 | 20 | 30 | - | - | 150 |

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:

- 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: T2425406**

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|--|--|------------------------|
| <p><i>TSO 1a.</i> Identify various types of loadings in the given machine components.</p> <p><i>TSO 1b.</i> Select suitable elastic moduli in the given problem with justification.</p> <p><i>TSO 1c.</i> Evaluate behavior of the given material subjected to static longitudinal, lateral loads and due to thermal stresses.</p> <p><i>TSO 1d.</i> Estimate direct stresses and strains in the given composite and compound section.</p> | <p>Unit-1.0 Stresses and Strains</p> <p>1.1 Different types of Loads</p> <p>1.2 Direct Stress, linear Strain, Hook's Law Calculation of direct stress and linear strain, stress- strain curve of mild Steel, modulus of elasticity, yield, breaking and ultimate stress and factor of safety</p> <p>1.3 Lateral strain and Poisson's ratio</p> <p>1.4 Temperature stress and strain with and without yielding</p> <p>1.5 Shear stress, shear strain and shear modulus</p> <p>1.6 Bulk modulus and volumetric strain</p> | CO1 |
| <p><i>TSO 2a.</i> Analyze the given machine components subjected to lateral and axial eccentric loads.</p> <p><i>TSO 2b.</i> Calculate resultant stress and draw resultant stress variation diagram for the given axial eccentric situation.</p> <p><i>TSO 2c.</i> Calculate Shear stress in given situation.</p> <p><i>TSO 2d.</i> Draw Shear force and bending moment diagram for the given statically determinate beam.</p> <p><i>TSO 2e.</i> Calculate the distance of point of contra flexure in the given bending moment diagrams.</p> | <p>Unit-2.0 Shear Force and Bending Moment Diagrams</p> <p>2.1 Structural components subjected to axial eccentric Loads</p> <p>2.2 Shear stress: Average and maximum shear stress for rectangular and circular section.</p> <p>2.3 Statically determinate beams like cantilever, simply supported and over hanging beam</p> <p>2.4 Relation between shear force and bending moment</p> <p>2.5 Sagging and hogging bending moment and its importance</p> <p>2.6 Point of contra flexure and its importance.</p> <p>2.7 S.F and B.M. diagram for cantilever, simply supported and over hanging beam</p> | CO2 |
| <p><i>TSO 3a.</i> Derive bending stress equation for a beam of rectangular cross section.</p> <p><i>TSO 3a.</i> Calculate bending stress in the given component/element.</p> <p><i>TSO 3b.</i> Determine deflection and slope in a given statically determinate beam.</p> | <p>Unit-3.0 Theory of Simple Bending and Deflection of Beams</p> <p>3.1 Bending theory equation, Bending stress and Sectional modulus</p> <p>3.2 Neutral axis, application of bending theory to statically determinate beams/elements like shaft, axle, spindle, pulley arm having rectangular or circular section</p> <p>3.3 Slope and deflection, Deflection for Cantilever Beams subjected to Point Load at free end and with full Uniformly distributed load (UDL)</p> <p>3.4 Simply supported Beam subjected to Point Load at Mid Span and with UDL at whole spa.</p> | CO3 |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|--|------------------------|
| <p><i>TSO 4a.</i> Calculate the power transmitted by the given solid and hollow shafts.</p> <p><i>TSO 4b.</i> Calculate angle of twist and shear strain in the given solid shaft.</p> <p><i>TSO 4c.</i> Estimate strain energy for the given spring with axially loaded member</p> <p><i>TSO 4d.</i> Select a spring based on the given situation with justification.</p> <p><i>TSO 4e.</i> Calculate Stiffness, deflection and maximum stress in the given spring.</p> | <p>Unit-4.0 Torsion in Shafts and Springs</p> <p>4.1. Definition and function of a shaft</p> <p>4.2. Moment of inertia, Polar moment of inertia, Torsion, Angle of Twist, Torsional Rigidity, Torsional Stress</p> <p>4.3. Power Transmitted/Consumed for shaft, spindle and axle of solid and hollow sections subjected to Torsion</p> <p>4.4. Definition, types and application of springs</p> <p>4.5. Spring classification based on size, shape and load- helical and spiral spring.</p> <p>4.6. Stiffness, deflection and maximum stress in helical open and closed coil springs</p> | CO4, CO5 |
| <p><i>TSO 5a.</i> Analyze the Robotic components that can be treated as column struts.</p> <p><i>TSO 5b.</i> Determine the Euler's Crippling Load for column for the given loading situation.</p> <p><i>TSO 5c.</i> Estimate slenderness ratio for the given column/strut.</p> <p><i>TSO 5d.</i> Determine Rankine's load / Buckling Load of Column for the given loading situation.</p> | <p>Unit-5.0 Buckling Stresses in Columns and Struts</p> <p>5.1 Column and Strut</p> <p>5.2 Short and Long Column</p> <p>5.3 End Conditions of Column</p> <p>5.4 Effective Length of Column and Modes of Failure in column.</p> <p>5.5 Radius of Gyration, Slenderness Ratio.</p> <p>5.6 Euler's Crippling Load and its application.</p> <p>5.7 Rankine's load / Buckling Load and its application.</p> | CO6 |

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) Suggested Term Work and Self Learning: S2425406 Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments:

1. Prepare a list of different loads and analyze their effects on a given robotic component.
2. Collect specification of Universal Testing Machine (UTM) in your lab and nearby industry and compare those specifications.
3. Prepare a list of robotic components subjected to lateral loads and identify end conditions and types of loading.
4. Prepare a table for maximum deflections in the given Simply Supported and Cantilever beam.
5. Prepare a report on the applications of different type of springs.
6. Compare torsional rigidity for shafts of same length, diameters but of different materials.

b. Micro Projects:

1. Construct a model showing the effects of thermal stresses on beams.
2. Prepare a model of wood showing various beams and their supports.
3. Identify different parts subjected to bending stresses in a lathe/shaper/planer machines in Mechanical Workshop and compare them with the standard beams and prepare a report on the basis of given criteria.
4. Visit nearby industries (minimum 03 industries) and list the various power transmission devices

with their technical specifications.

5. Market Survey specific to properties of Various type of Materials used in Robotic Engineering and make report
6. Prepare a model of acrylic column and make provision for all four types of end conditions. Try to predict the equivalent length from it.

C. Other Activities:

1. Seminar Topics:

- Comparison between static and dynamic loads on robotic elements.
- SF and BM variations in standard robotic components.
- Different types of beams with examples.

2. Visits:

- Visit a nearby automation industry and prepare a detailed report on the various failures of robotic components with reason, their life cycle etc.
- Visit a robotic element service center and prepare a detailed report on the usage of helical/leaf spring mentioning their specifications and their failures in various robotic components.

3. Self-learning topics:

- Beams of uniform strength
- Beams of varying cross section
- Spiral springs
- Compound Shafts under torsion
- Struts and columns under different loading conditions.

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 | 20% | 20% | 20% | 20% | 20% | - | - |
| CO-2 | 10% | 10% | 10% | 20% | 20% | - | - |
| CO-3 | 15% | 15% | 15% | 20% | 20% | - | - |
| CO-4 | 20% | 20% | 20% | 20% | 15% | - | - |
| CO-5 | 20% | 20% | 20% | - | 15% | - | - |
| CO-6 | 15% | 15% | 15% | 20% | 10% | - | - |
| Total Marks | 30 | 70 | 20 | 20 | 10 | - | - |
| | | | 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 Simple Stresses and Strains | 12 | CO1 | 16 | 5 | 5 | 6 |
| Unit-2.0 Shear Force & Bending Moment Diagrams | 8 | CO2 | 14 | 4 | 4 | 6 |
| Unit-3.0 Theory of Simple Bending and Deflection of Beams | 10 | CO3 | 14 | 4 | 4 | 6 |
| Unit-4.0 Torsion in shafts and springs | 12 | CO4, CO5 | 16 | 4 | 6 | 6 |
| Unit-5.0 Buckling Stresses in Columns and Struts type Components | 6 | CO6 | 10 | 3 | 3 | 4 |
| 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): (Not Applicable)

P) Suggested Instructional/Implementation Strategies: Different Instructional/ Implementation Strategies maybe 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

Q) List of Major Laboratory Equipment, Tools and Software: (Not Applicable)

R) Suggested Learning Resources:

(a) Books:

| S. No. | Titles | Author(s) | Publisher and Edition with ISBN |
|--------|--|--------------------------|---|
| 1. | Strength of Material | S. Ramamurtham | Dhanpat Rai Publication; 20 th edition, 2014, ISBN: 978-9384378264 |
| 2. | Strength of Material | Timoshenko and Gere | CBS, 2 nd edition, 2006, ISBN: 978-8123908946 |
| 3. | Strength of Material and Mechanics of Structures | B. C. Punamia | Laxmi Publications (P) Ltd. New Delhi, 10 th edition, 2018, ISBN: 978-8131809259 |
| 4. | Strength of Materials | R. S. Khurmi & N. Khurmi | S. Chand Publication, 26 th edition, 2015, ISBN: 978-9385401954 |
| 5. | Strength of Materials | S. S. Rattan | McGraw Hill Education; 3 rd edition, 2017, ISBN: 978-9385965517 |
| 6. | Strength of Materials | R.K. Rajput | S. Chand Publication, 7 th Edition, 2022, ISBN: 978-9355010704 |

(b) Online Educational Resources:

1. <https://www.youtube.com/watch?v=A1SWKe6ZwVc&list=PL521D094C8752CE67>
2. <https://sm-nitk.vlabs.ac.in/List%20of%20experiments.html>
3. <https://archive.nptel.ac.in/courses/112/107/112107147/>
4. www.wikipedia.org/wiki/Shear_and_moment_diagram
5. www.freestudy.co.uk/mech%20prin%20h2/stress.pdf
6. www.engineerstudent.co.uk/stress_and_strain.html
7. www.iit.edu/arc/workshops/pdfs/Moment_Inertia.pdf

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational resources before use by the students.

(c) Others:

1. Robotic magazines like real robot, Robotics and Automation news etc.
2. Lab Manuals
4. Users' Guide
5. Manufacturers' Manual
6. Learning Packages

- A) **Course Code** : 2400007(T2400007)
 B) **Course Title** : Indian Constitution (Common for all Programmes)
 C) **Pre- requisite Course(s)** :
 D) **Rationale** :

This course will focus on the basic structure and operative dimensions of Indian Constitution. It will explore various aspects of the Indian political and legal system from a historical perspective highlighting the various events that led to the making of the Indian Constitution. The Constitution of India is the supreme law of India. The document lays down the framework demarcating the fundamental political code, structure, procedures, powers, and sets out fundamental rights, directive principles, and the duties of citizens. The course on constitution of India highlights key features of Indian Constitution that makes the students a responsible citizen. In this online course, we shall make an effort to understand the history of our constitution, the Constituent Assembly, the drafting of the constitution, the preamble of the constitution that defines the destination that we want to reach through our constitution, the fundamental right constitution guarantees through the great rights revolution, the relationship between fundamental rights and fundamental duties, the futurist goals of the constitution as incorporated in directive principles and the relationship between fundamental rights and directive principles.

- E) **Course Outcomes (COs):** After the completion of the course, teachers are expected to ensure the accomplishment of following course out comes 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** List salient features and characteristics of the constitution of India.
CO-2 Follow fundamental rights and duties as responsible citizen and engineer of the country.
CO-3 Analyze major constitutional amendments in the constitution.

- 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 | 1 | - | - | - | 2 | - | - | | |
| CO-2 | 1 | - | - | - | 2 | - | - | | |
| CO-3 | 1 | 2 | - | - | 2 | - | 1 | | |

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 | | | | |
| | 2400007 | Indian Constitution | 01 | - | - | 01 | 01 | 01 |

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) | |
| | 2400007 | Indian Constitution | 25 | - | - | - | - | - | 25 |

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:

- 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: T2400007

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|---|--|------------------------|
| TSO 1a. Explain the meaning of preamble of the constitution. TSO 1b. List the salient features of constitution. TSO 1c. List the characteristics of constitution. | Unit-1.0 Constitution and Preamble 1.1 Meaning of the constitution of India. 1.2 Historical perspective of the Constitution of India. 1.3 Salient features and characteristics of the Constitution of India. 1.4 Preamble to the Constitution of India. | CO1 |
| TSO 2a. Enlist the fundamental rights. TSO 2b. Identify fundamental duties in general and in particular with engineering field. TSO 2c. identify situations where directive principles prevail over fundamental rights. | Unit-2.0 Fundamental Rights and Directive Principles 2.1 Fundamental Rights under Part-III. 2.2 Fundamental duties and their significance. 2.3 Relevance of Directive Principles of State Policy under part-IV. | CO2 |
| TSO 3a. Enlist the constitutional amendments. TSO 3b. Analyze the purposes of various amendments. | Unit-3.0 Governance and Amendments 3.1 Amendment of the Constitutional Powers and Procedure 3.2 Major Constitutional Amendment procedure - 42nd, 44th, 74th, 76th, 86th and 91st | CO3 |

Note: One major TSO may require more than one Theory session/Period.

K) Suggested Laboratory (Practical) Session Outcomes (LSOs) and List of Practical: (Not Applicable)

L) Suggested Term Work and Self Learning: 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:

1. Role of Media in Spreading Awareness regarding Fundamental Rights
2. Analysis of Situations where directive principle of State policy has prevailed over Fundamental rights
3. Analyze 42nd and 97th Amendment of Indian Constitution

c. Other Activities:

1. Seminar Topics:
 - Democracy and Political Participation in India
 - Situations where directive principles prevail over fundamental rights.
2. Visits:
 - Arrange Mock Parliament.
3. Design games and simulation on emergencies declared in last thirty years.
4. Group discussions on current print articles.

- Adoption of Article 365 in India.
 - Need of amendments in the constitution.
5. Prepare collage/posters on current constitutional issues.
- Emergencies declared in India
 - Seven fundamental rights
6. Cases: Suggestive cases for usage in teaching:

| Case | Relevance |
|-----------------------------|--|
| A.K. Gopalan Case (1950) | SC contended that there was no violation of Fundamental Rights enshrined in Articles 13, 19, 21 and 22 under the provisions of the Preventive Detention Act, if the detention was as per the procedure established by law. Here, the SC took a narrow view of Article 21. |
| Shankari Prasad Case (1951) | This case dealt with the amendability of Fundamental Rights (the First Amendment's validity was challenged). The SC contended that the Parliament's power to amend under Article 368 also includes the power to amend the Fundamental Rights guaranteed in Part III of the Constitution. |
| Minerva Mills case (1980) | This case again strengthens the Basic Structure doctrine. The judgement struck down 2 changes made to the Constitution by the 42nd Amendment Act 1976, declaring them to violate the basic structure. The judgement makes it clear that the Constitution, and not the Parliament is supreme. |
| Maneka Gandhi case (1978) | A main issue in this case was whether the right to go abroad is a part of the Right to Personal Liberty under Article 21. The SC held that it is included in the Right to Personal Liberty. The SC also ruled that the mere existence of an enabling law was not enough to restrain personal liberty. Such a law must also be "just, fair and reasonable." |

7. Self-learning topics:

- Parts of the constitution and a brief discussion of each part.
- Right to education.
- Right to equality.

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 | 30% | - | 30% | - | - | - | - |
| CO-2 | 40% | - | 40% | 50% | 50% | - | - |
| CO-3 | 30% | - | 30% | 50% | 50% | - | - |
| Total Marks | 25 | - | 5 | 10 | 10 | - | - |
| | | | 25 | | | | |

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: (Not Applicable)**O) Suggested Assessment Table for Laboratory (Practical): (Not Applicable)**

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: (Not Applicable)**R) Suggested Learning Resources:****(a) Books:**

| S. No. | Titles | Author(s) | Publisher and Edition with ISBN |
|--------|---------------------------------------|----------------|--|
| 1. | The Constitution of India | P.M.Bakshi | Universal Law Publishing, New Delhi 15th edition, 2018, ISBN: 9386515105 |
| 2. | Introduction to Indian Constitution | D.D.Basu | Lexis Nexis Publisher, New Delhi, 2015, ISBN:935143446X |
| 3. | Introduction to Constitution of India | B. K. Sharma | PHI, New Delhi, 6th edition, 2011, ISBN:8120344197 |
| 4. | The Constitution of India | B.L. Fadia | Sahitya Bhawan, Agra, 2017, ISBN:8193413768 |
| 5. | The Constitutional Law of India | Durga Das Basu | LexisNexis Butterworths Wadhwa, Nagpur 978-81-8038-426-4 |

(b) Online Educational Resources:

1. <https://www.coursera.org/learn/principles-of-management>
2. <http://www.legislative.gov.in/constitution-of-india>
3. https://en.wikipedia.org/wiki/Constitution_of_India
4. <https://www.india.gov.in/my-government/constitution-india>
5. <https://eci.gov.in/about/about-eci/the-setup-r1/>
6. <https://www.toppr.com/guides/civics/the-indian-constitution/the-constitution-of-india/>
7. <https://main.sci.gov.in/constitution>
8. <https://nios.ac.in/media/documents/srsec317newE/317EL8.pdf>
9. <https://legalaffairs.gov.in/sites/default/files/chapter%203.pdf>

10. https://www.concourt.am/armenian/legal_resources/world_constitutions/constit/india/india-e.htm
11. <https://constitutionnet.org/vl/item/basic-structure-indian-constitution>

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:

- A) **Course Code** : 2400110(T2400110)
- B) **Course Title** : Community/ Society Development (Non-Exam Course)
(AIML, AE, CSE, ELX (R), CHE, EE, ME, ME (Auto), MIE, FTS, CACDDM)
- C) **Pre- requisite Course(s)** :
- D) **Rationale** :

Community development is a process in which community members collectively generate solutions to common problems/concerns for improvement in the quality of life of the people. The course in community and society development is essential so that students can be prepared for taking up activities for the welfare and social well-being of the community and society around them. This course has been designed to develop requisite competencies and skills in students so that they can address social problems, develop sustainable solutions that are tailored to local needs and resources, engage with local communities and civil society organizations to promote people's participation in decision-making and accountability, and apply them to community development.

- 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** Identify the issues and problems faced by local communities/societies that can be addressed through community development schemes for sustainable development.
- CO-2** Prepare an action plan for an identified issue under community development scheme for a selected area.

- 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 | 1 | 1 | 3 | 2 | 2 | | |
| CO-2 | 3 | 2 | 1 | 1 | 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 is optional

G) Teaching & Learning Scheme:

| Course Title | Scheme of Study (Hours/Week) | | | | |
|--------------------------------|------------------------------|---|-------------------------------------|---------------------------------|-------------------|
| | Classroom Instruction (CI) | | Notional Hours (TW/ Activities+ SL) | Total Hours (CI+TW/ Activities) | Total Credits (C) |
| | L | T | | | |
| Community/ Society Development | 01 | - | - | 01 | 01 |

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) 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.

I) Theory Session Outcomes (TSOs) and Units: T2400110

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|--|---|------------------------|
| <p><i>TSO 1a.</i> Explain the concept of to Community/Society in Indian Context</p> <p><i>TSO 1b.</i> Explain the concept of Rural and Urban Society</p> <p><i>TSO 1c.</i> Differentiate between Rural and Urban Societies.</p> <p><i>TSO 1d.</i> Differentiate between Underdevelopment and development.</p> <p><i>TSO 1e.</i> Describe the different components of community development</p> | <p>Unit-1.0 Community and Society Development Framework</p> <p>1.1 Concept of Community/Society Development</p> <p>1.2 Difference between Rural and Urban Societies</p> <p>1.3 Characteristics of Underdevelopment and development</p> <p>1.4 Components of Community Development</p> | CO1 |
| <p><i>TSO 2a.</i> Prepare a brief report on Community Development Programmes in India considering the given criteria</p> <p><i>TSO 2b.</i> Prepare a brief report on institutions engaged in community development programmes considering the given criteria</p> <p><i>TSO 2c.</i> Explain the framework of sustainable community development</p> | <p>Unit-2 Community Development Initiatives</p> <p>2.1 Community Development Programmes in India- Historical perspective</p> <p>2.2 Institutions Engaged in Community Development Programmes</p> <p>2.3 Contemporary Community Development Initiatives.</p> <p>2.4 Sustainable Community Development</p> | CO1, CO2 |

| Major Theory Session Outcomes (TSOs) | Units | Relevant COs Number(s) |
|--|--|------------------------|
| <p><i>TSO 3a.</i> Explain Role of Technical Intuitions in Community/Society development.</p> <p><i>TSO 3b.</i> Summarise the activities undertaken by technical institutions under community development through polytechnic scheme</p> <p><i>TSO 3c.</i> Prepare a plan for undertaking project to support Unnat Bharat Abhiyan</p> | <p>Unit-3.0 Community Development Schemes</p> <p>3.1 Role of polytechnics in Community development.</p> <p>3.2 Scheme of Community Development through Polytechnics</p> <p>3.3 Unnat Bharat Abhiyan</p> | <p>CO3, CO4</p> |

Note: One major TSO may require more than one Theory session/Period.

J) Suggested Term Work/ Activities and Self Learning: Some sample suggested assignments, micro project and other activities are mentioned here for reference.

a. Assignments: Specific assignments will be given to students for preparing report on community development programmes and institutions engaged in community development programmes.

b. Micro Projects:

1. Suggest solution for flowing water near a water source.
2. Identify locally available construction materials in a village.
3. Suggest a plan for disposal of solid waste in a village.
4. Prepare a plan for use of solar light equipments at streets and public places.

c. Other Activities:

1. Seminar Topics:

- Issues of development for a village near to the institution.
- Activities to be undertaken by the polytechnic in a village.
- Characteristics of Development and underdevelopment.

2. Visits: Visit to nearby village may be arranged and students may be asked to prepare list of development activities in different Discipline.

3. Self-learning topics:

- Community Development programmes in India after independence.
- Schemes of GOI for Community /society Development.

K) 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.

L) List of Major Laboratory Equipment, Tools and Software:(Not Applicable)

M) Suggested Learning Resources:**(a) Books and Reports:**

| S. No. | Titles | Author(s) | Publisher and Edition with ISBN |
|--------|--|---|--|
| 1. | Module on Rural Development: Indian Context | IGNOU, New Delhi | Published by IGNOU, New Delhi |
| 2. | Module on Rural Development Programmes | IGNOU, New Delhi | Published by IGNOU, New Delhi |
| 3. | Module on Rural development planning and management | IGNOU, New Delhi | Published by IGNOU, New Delhi |
| 4. | India's Developing Villages | G R Madan | Allied Publishers, 1990 |
| 5. | Five year plans, Plan Documents, Policy and Reports | Planning Commission of India publications | Planning Commission of India |
| 6. | Scheme of Community Development through Polytechnics | Ministry of Human Resource Development, Shastri Bhavan ,New Delhi | Ministry of Human Resource Development, Govt of India, New Delhi |

(b) Online Educational Resources:

1. https://www.google.co.in/books/edition/Rural_Development/hABduOX-X-gC?hl=en&gbpv=1&dq=rural+development+latest+books&printsec=frontcover
2. <https://www.india.gov.in/my-government/documents/plan-document>
3. <https://www.india.gov.in/website-planning-commission>

Note: Teachers are requested to check the creative commons license status/ financial implications of the suggested, online educational resources before use by the students.

(c) Others:

1. Project Reports Available in the office of CEO, Zila Parishad of the District.
2. Schemes of various departments of Bihar Government for Community/Social Development
