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## Maharashtra State Board Of Technical Education, Mumbai

## Learning and Assessment Scheme for Post S.S.C Diploma Courses

| | | | |
|---|---|---|---|
| **Programme Name** | **: Diploma In Mechatronics** | | |
| **Programme Code** | **: MK** | **With Effect From Academic Year** | **: 2023-24** |
| **Duration Of Programme** | **: 6 Semester** | **Duration** | **: 16 WEEKS** |
| **Semester** | **: Fourth** **NCrF Entry Level : 3.5** | **Scheme** | **: K** |

| Sr No | Course Title | Abbrevation | Course Type | Course Code | Total IKS Hrs for Sem. | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Actual Contact Hrs./Week | | | Self Learning (Activity/ Assignment /Micro Project) | Notional Learning Hrs /Week | | Paper Duration (hrs.) | Theory | | | | Based on LL & TL | | | | Based on Self Learning | | Total Marks |
| | | | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| **(All Compulsory)** | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | ENVIRONMENTAL EDUCATION AND SUSTAINABILITY | EES | VEC | 314301 | 2 | 3 | - | - | 1 | 4 | 2 | 1.5 | 30 | 70*# | 100 | 40 | - | - | - | - | 25 | 10 | 125 |
| 2 | THEORY OF MACHINES | TOM | DSC | 313313 | - | 4 | - | 2 | - | 6 | 3 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | - | - | - | - | 125 |
| 3 | CONTROL SYSTEMS | CSS | DSC | 314337 | - | 3 | - | 2 | 1 | 6 | 3 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | - | - | 25 | 10 | 150 |
| 4 | EMBEDDED SYSTEM USING 'C' | ESC | AEC | 314338 | - | 3 | - | 4 | 1 | 8 | 4 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | - | - | 25 | 10 | 150 |
| 5 | FLUID POWER AND INDUSTRIAL AUTOMATION | IAU | DSC | 314339 | - | 3 | - | 2 | 1 | 6 | 3 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | 25# | 10 | 25 | 10 | 175 |
| 6 | ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS | EDS | AEC | 314014 | - | 1 | - | 2 | 1 | 4 | 2 | - | - | - | - | - | 50 | 20 | 25@ | 10 | 25 | 10 | 100 |
| 7 | COMPUTER AIDED MECHATRONICS DRAFTING | CAM | SEC | 314015 | - | - | - | 4 | 2 | 6 | 3 | - | - | - | - | - | 25 | 10 | 25# | 10 | 25 | 10 | 75 |
| **Total** | | | | | **2** | **17** | | **16** | **7** | | **20** | | **150** | **350** | **500** | | **175** | | **75** | | **150** | | **900** |

| Sr No | Course Title | Abbrevation | Course Type | Course Code | Total IKS Hrs for Sem. | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Actual Contact Hrs./Week | | | Self Learning (Activity/ Assignment /Micro Project) | Notional Learning Hrs /Week | | Paper Duration (hrs.) | Theory | | | | Based on LL & TL | | | | Based on Self Learning | | Total Marks |
| | | | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |

**Abbreviations :** CL- Classroom Learning , TL- Tutorial Learning, LL-Laboratory Learning, FA - Formative Assessment,SA -Summative Assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
**Legends :** @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
**Note :**
1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

**Course Category :** Discipline Specific Course Core (DSC) , Discipline Specific Elective (DSE) , Value Education Course (VEC) , Intern./Apprenti./Project./Community (INP) , AbilityEnhancement Course (AEC) , Skill Enhancement Course (SEC) , GenericElective (GE)

**ENVIRONMENTAL EDUCATION AND SUSTAINABILITY** **Course Code : 314301**

| | |
|---|---|
| **Programme Name/s** | **: Architecture Assistantship/ Automobile Engineering./ Artificial Intelligence/ Agricultural Engineering/ Artificial Intelligence and Machine Learning/ Automation and Robotics/ Architecture/ Cloud Computing and Big Data/ Civil Engineering/ Chemical Engineering/ Computer Technology/ Computer Engineering/ Civil & Rural Engineering/ Construction Technology/ Computer Science & Engineering/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Digital Electronics/ Data Sciences/ Electrical Engineering/ Electronics & Tele-communication Engg./ Electrical and Electronics Engineering/ Electrical Power System/ Electronics & Communication Engg./ Electronics Engineering/ Food Technology/ Computer Hardware & Maintenance/ Instrumentation & Control/ Industrial Electronics/ Information Technology/ Computer Science & Information Technology/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Civil & Environmental Engineering/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Polymer Technology/ Surface Coating Technology/ Computer Science/ Textile Technology/ Electronics & Computer Engg./ Travel and Tourism/ Textile Manufactures/** |
| **Programme Code** | **: AA/ AE/ AI/ AL/ AN/ AO/ AT/ BD/ CE/ CH/ CM/ CO/ CR/ CS/ CW/ DC/ DD/ DE/ DS/ EE/ EJ/ EK/ EP/ ET/ EX/ FC/ HA/ IC/ IE/ IF/ IH/ IS/ IX/ IZ/ LE/ ME/ MK/ ML/ MU/ PG/ PN/ PO/ SC/ SE/ TC/ TE/ TR/ TX** |
| **Semester** | **: Fourth** |
| **Course Title** | **: ENVIRONMENTAL EDUCATION AND SUSTAINABILITY** |
| **Course Code** | **: 314301** |

## I. RATIONALE

The survival of human beings is solely depending upon the nature. Thus, threats to the environment directly impact on existence and health of humans as well as other species. Depletion of natural resources and degradation of ecosystems is accelerated due to the growth in industrial development, population growth, and overall growth in production demand. To address these environmental issues, awareness and participation of individuals as well as society is necessary. Environmental education and sustainability provide an integrated, and interdisciplinary approach to study the environmental systems and sustainability approach to the diploma engineers.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Resolve the relevant environmental issue through sustainable solutions

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify the relevant Environmental issues in specified locality.
- CO2 - Provide the green solution to the relevant environmental problems.
- CO3 - Conduct SWOT analysis of biodiversity hotspot
- CO4 - Apply the relevant measures to mitigate the environmental pollution.
- CO5 - Implement the environmental policies under the relevant legal framework.

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**ENVIRONMENTAL EDUCATION AND SUSTAINABILITY** **Course Code : 314301**

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | Total Marks |
| | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 314301 | ENVIRONMENTAL EDUCATION AND SUSTAINABILITY | EES | VEC | 3 | - | - | 1 | 4 | 2 | 1.5 | 30 | 70*# | 100 | 40 | - | - | - | - | 25 | 10 | 125 |

**Total IKS Hrs for Sem. :** 2 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

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4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 Explain the need of studying environment and its components.<br>TLO 1.2 Investigate the impact of population growth and industrialization on the relevant environmental issues and suggest remedial solutions<br>TLO 1.3 Explain the Concept of 5 R w.r.t. the given situation<br>TLO 1.4 Elaborate the relevance of Sustainable Development Goals in managing the climate change<br>TLO 1.5 Explain the concept of zero carbon-footprint with carbon credit | **Unit - I Environment and climate change**<br>1.1 Environment and its components, Types of Environments, Need of environmental studies<br>1.2 Environmental Issues- Climate change, Global warming, Acid rain, Ozone layer depletion, nuclear accidents. Effect of population growth and industrialization<br>1.3 Concept of 5R, Individuals' participation in i) 5R policy, ii) segregation of waste, and iii) creating manure from domestic waste<br>1.4 Impact of Climate change, Factors contributing to climate change, Concept of Sustainable development, Sustainable development Goals (SDGs), Action Plan on Climate Change in Indian perspectives<br>1.5 Zero Carbon footprint for sustainable development, (IKS-Enviornment conservation in vedic and pre-vedic India) | Lecture Using Chalk-Board Presentations |

**ENVIRONMENTAL EDUCATION AND SUSTAINABILITY** **Course Code : 314301**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 2 | TLO 2.1 Justify the importance of natural resources in sustainable development<br>TLO 2.2 Explain the need of optimum use of natural resources to maintain the sustainability<br>TLO 2.3 Differentiate between renewable and non-renewable sources of energy<br>TLO 2.4 Suggest the relevant type of energy source as a green solution to environmental issues | **Unit - II Sustainability and Renewable Resources**<br>2.1 Natural Resources: Types, importance, Causes and effects of depletion. (Forest Resources, Water Resources, Energy Resources, Land resources, Mineral resources), (IKS-Concepts of Panchmahabhuta)<br>2.2 Impact of overexploitation of natural resources on the environment, optimum use of natural resources<br>2.3 Energy forms (Renewable and non-renewable) such as Thermal energy, nuclear energy, Solar energy, Wind energy, Geothermal energy, Biomass energy, Hydropower energy, biofuel<br>2.4 Green Solutions in the form of New Energy Sources such as Hydrogen energy, Ocean energy & Tidal energy | Lecture Using Chalk-Board Presentations |
| 3 | TLO 3.1 Explain the characteristics and functions of ecosystem<br>TLO 3.2 Relate the importance of biodiversity and its loss in the environmental sustainability<br>TLO 3.3 Describe biodiversity assessment initiatives in India<br>TLO 3.4 Conduct the SWOT analysis of the biodiversity hot spot in India<br>TLO 3.5 Explain the need of conservation of biodiversity in the given situation | **Unit - III Ecosystem and Biodiversity**<br>3.1 Ecosystem - Definition, Aspects of ecosystem, Division of ecosystem, General characteristics of ecosystem, Functions of ecosystem<br>3.2 Biodiversity - Definitions, Levels, Value, and loss of biodiversity<br>3.3 Biodiversity Assessment Initiatives in India<br>3.4 SWOT analysis of biodiversity hot spot in India<br>3.5 Conservations of biodiversity - objects, and laws for conservation of biodiversity | Lecture Using Chalk-Board Presentations Video Demonstrations |

**ENVIRONMENTAL EDUCATION AND SUSTAINABILITY** **Course Code : 314301**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 4 | TLO 4.1 Classify the pollution based on the given criteria<br>TLO 4.2 Justify the need of preserving soil as a resource along with the preservation techniques<br>TLO 4.3 Maintain the quality of water in the given location using relevant preventive measures<br>TLO 4.4 State the significance of controlling the air pollution to maintain its ambient quality norms<br>TLO 4.5 Compare the noise level from different zones of city with justification<br>TLO 4.6 Describe the roles and responsibilities of central and state pollution control board | **Unit - IV Environmental Pollution**<br>4.1 Definition of pollution, types- Natural & Artificial (Man- made)<br>4.2 Soil / Land Pollution – Need of preservation of soil resource, Causes and effects on environment and lives, preventive measures, Soil conservation<br>4.3 Water Pollution - sources of water pollution, effects on environment and lives, preventive measures, BIS water quality standards for domestic potable water, water conservation<br>4.4 Air pollution - Causes, effects, prevention, CPCB norms of ambient air quality in residential area<br>4.5 Noise pollution - Sources, effects, prevention, noise levels at various zones of the city<br>4.6 Pollution Control Boards at Central and State Government level: Norms, Roles and Responsibilities | Lecture Using Chalk-Board Presentations |
| 5 | TLO 5.1 Explain Constitutional provisions related to environmental protection<br>TLO 5.2 Explain importance of public participation (PPP) in enacting the relevant laws<br>TLO 5.3 Use the relevant green technologies to provide sustainable solutions of an environmental problem<br>TLO 5.4 Explain the role of information technology in environment protection | **Unit - V Enviornmental legislation and sustainable practices**<br>5.1 Article (48-A) and (51-A (g)) of Indian Constitution regarding environment, Environmental protection and prevention acts<br>5.2 Public awareness about environment. Need of public awareness and individuals' participation. Role of NGOs<br>5.3 Green technologies like solar desalination, green architecture, vertical farming and hydroponics, electric vehicles, plant-based packaging<br>5.4 Role of information technology in environment protection and human health | Lecture Using Chalk-Board Presentations Video Demonstrations |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES : NOT APPLICABLE.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**Assignment**

•

Suggest the steps to implement (or improve the implementation) of the 5R policy in your home/institute stating your contribution
Draft an article on India's Strategies to progress across the Sustainable Development Goals
Make a chart of Renewable and non-renewable energy sources mentioning the advantages and disadvantages of each

source
Conduct the SWOT analysis of biodiversity hotspot in India
Prepare a mind-mapping for the zero carbon footprint process of your field
Prepare a chart showing sources of pollution (air/water/ soil), its effect on human beings, and remedial actions
Any other assignment on relevant topic related to the course suggested by the facilitator

**UNICEF Certification(s)**

- Students may complete the self-paced course launched by Youth Leadership for climate Exchange under UNICEF program on portal www.mahayouthnet.in . The course encompasses five Modules in the form of Units as given below: -

Unit 1: Living with climate change
Unit 2 : Water Management and Climate Action
Unit 3: Energy Management and Climate Action
Unit 4 : Waste Management and Climate Action
Unit 5 : Bio-cultural Diversity and Climate Action
If students complete all the five Units they are not required to undertake any other assignment /Microproject/activities specified in the course. These units will suffice to their evaluations under SLA component

**Micro project**

-

Technical analysis of nearby commercial RO plant.
Comparative study of different filters used in Household water filtration unit
Evaluate any nearby biogas plant / vermicomposting plant or any such composting unit on the basis of sustainabilityand cost-benefit
IKS-Study and prepare a note on Vedic and Pre-Vedic techniques of environmental conversion
Visit a local polluted water source and make a report mentioning causes of pollution
Any other activity / relevant topic related to the course suggested by the facilitator

**Activities**

-

Prepare a report on the working and functions of the PUC Center machines and its relavance in pollution control.
Prepare and analyse a case study on any polluted city of India
Prepare a note based on the field visit to the solid waste management department of the municipal corporation / local authority
Record the biodiversity of your institute/garden in your city mentioning types of vegetation and their numbers
Visit any functional hall/cultural hall /community hall to study the disposal techniques of kitchen waste and prepare a report suggesting sustainable waste management tool
Watch a video related to air pollution in India and present the summary
Any other assignment on relevant topic related to the course suggested by the facilitator

**ENVIRONMENTAL EDUCATION AND SUSTAINABILITY** **Course Code : 314301**

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | Nil | All |

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | I | Environment and climate change | CO1 | 8 | 4 | 4 | 4 | 12 |
| 2 | II | Sustainability and Renewable Resources | CO2 | 10 | 4 | 4 | 8 | 16 |
| 3 | III | Ecosystem and Biodiversity | CO3 | 8 | 4 | 4 | 4 | 12 |
| 4 | IV | Environmental Pollution | CO4 | 12 | 4 | 8 | 6 | 18 |
| 5 | V | Enviornmental legislation and sustainable practices | CO5 | 7 | 4 | 4 | 4 | 12 |
| **Grand Total** | | | | **45** | **20** | **24** | **26** | **70** |

## X. ASSESSMENT METHODOLOGIES/TOOLS

**Formative assessment (Assessment for Learning)**

- Two-unit tests (MCQs) of 30 marks will be conducted and average of two-unit tests considered. Formative assessment of self learning of 25 marks should be assessed based on self learning activity such as UNICEF Certification(s)/Microproject/assignment/activities. (60 % weightage to process and 40 % to product)

**Summative Assessment (Assessment of Learning)**

- Online MCQ type Exam

## XI. SUGGESTED COS - POS MATRIX FORM

**ENVIRONMENTAL EDUCATION AND SUSTAINABILITY** **Course Code : 314301**

| 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 | PSO-3 |
| CO1 | - | 1 | - | - | 3 | 2 | 3 | | | |
| CO2 | - | 2 | 2 | - | 3 | 2 | 3 | | | |
| CO3 | - | - | - | - | 3 | 1 | 2 | | | |
| CO4 | 1 | - | - | - | 3 | 2 | 2 | | | |
| CO5 | 1 | - | 2 | - | 3 | 2 | 3 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | Y. K. Singh | Environmental Science | New Age International Publishers, 2006, ISBN: 81-224-2330-2 |
| 2 | Erach Bharucha | Environmental Studies | University Grants Commission, New Delhi |
| 3 | Rajagopalan R. | Environmental Studies: From Crisis to Cure. | Oxford University Press, USA, ISBN: 9780199459759, 0199459754 |
| 4 | Shashi Chawla | A text book of Environmental Science | Tata Mc Graw-Hill New Delhi |
| 5 | Arvind Kumar | A Text Book of Enviornmental science | APH Publishing New Delhi (ISBN 978-8176485906) |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | https://sdgs.un.org/goals | United Nation’s website mentioning Sustainability goals |
| 2 | http://www.greenbeltmovement.org/news-and-events/blog | Green Belt Movement Blogs on various climatic changes and other issues |
| 3 | http://www.greenbeltmovement.org/what-we-do/tree-planting-fo r-watersheds | Green Belt Movement's work on tree plantation, soil conservation and watershed management techniques |
| 4 | https://www.youtube.com/@ierekcompany/videos | International Experts For Research Enrichment and Knowledge Exchange – IEREK's platform to exchange the knowledge in fields such as architecture, urban planning, sustainability |
| 5 | www.mahayouthnet.in | UNICEF Intiative for youth leadership for climate action |

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**ENVIRONMENTAL EDUCATION AND SUSTAINABILITY** **Course Code : 314301**

| Sr.No | Link / Portal | Description |
|---|---|---|
| 6 | https://eepmoefcc.nic.in/index1.aspx?lsid=297&lev=2&lid=1180&langid=1 | GOI Website for public awareness on enviornmetal issues |
| 7 | https://egyankosh.ac.in/handle/123456789/61136 | IGNOU's Intiative for online study material on Enviornmental studies |
| 8 | https://egyankosh.ac.in/handle/123456789/50898 | IGNOU's Intiative for online study material on sustainability |
| 9 | https://sustainabledevelopment.un.org/content/documents/11803Official-List-of-Proposed-SDG-Indicators.pdf | Final list of proposed Sustainable Development Goal indicators |
| 10 | https://sustainabledevelopment.un.org/memberstates/india | India’s Strategies to progress across the SDGs. |
| 11 | https://www.un.org/en/development/desa/financial-crisis/sustainable-development.html | Challenges to Sustainable Development |
| 12 | https://nptel.ac.in/courses/109105190 | NPTEL course on sustainable development |
| 13 | https://onlinecourses.swayam2.ac.in/cec19_bt03/preview | Swayam Course on Enviornmetal studies (Natural Resources, Biodiversity and other topics) |
| 14 | https://onlinecourses.nptel.ac.in/noc23_hs155/preview | NPTEL course on enviornmental studies which encomopasses SDGs, Pollution, Cliamate issues, Energy, Policies and legal framework |
| 15 | https://www.cbd.int/development/meetings/egmbped/SWOT-analysis-en.pdf | SWOT analysis of Biodiversity |
| 16 | https://www.sanskrit.nic.in/SVimarsha/V2/c17.pdf | Central sanskrkit university publication on Vedic and pre vedic enviornmetal conservation |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**MSBTE Approval Dt. 21/11/2024** **Semester - 4, K Scheme**

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**THEORY OF MACHINES** **Course Code : 313313**

| | |
|---|---|
| **Programme Name/s** | **: Automobile Engineering./ Mechanical Engineering/ Mechatronics/ Production Engineering/** |
| **Programme Code** | **: AE/ ME/ MK/ PG** |
| **Semester** | **: Third / Fourth** |
| **Course Title** | **: THEORY OF MACHINES** |
| **Course Code** | **: 313313** |

## I. RATIONALE

Diploma Engineer should be able to identify and interpret various elements of machines in day-to-day life when they come across various machines in practice. In maintaining various machines, a Diploma Engineer should have sound knowledge of fundamentals of machine and mechanism. TOM subject imparts the kinematics involved in different machine elements and mechanisms like I.C. engine, cam-follower, belt-pulley, gear, flywheel etc. This course serves as a prerequisite for other courses such as Machine Design of higher semester etc.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

This course will enable the students to: Apply the knowledge & skills related to machine, mechanism & motions according to field applications.

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply knowledge and skill related to different mechanisms and its motion in given situation.
- CO2 - Determine velocity and acceleration for given mechanism.
- CO3 - Develop a Cam profile for given type of Follower and its motions in given situation.
- CO4 - Select the suitable power transmission devices for the given field/industrial application.
- CO5 - Use knowledge and skills related to balancing of masses and vibration for various applications.

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | | Total Marks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | |
| | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 313313 | THEORY OF MACHINES | TOM | DSC | 4 | - | 2 | - | 6 | 3 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | - | - | - | - | 125 |

**THEORY OF MACHINES** **Course Code : 313313**

**Total IKS Hrs for Sem. :** 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
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## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 Identify various links and pairs in the given mechanism.<br>TLO 1.2 Identify various type motion in the given pair.<br>TLO 1.3 Identify various kinematic chain in the given configuration.<br>TLO 1.4 Estimate degree of freedom for given configuration.<br>TLO 1.5 Explain different inversion of mechanism.<br>TLO 1.6 Select suitable inversion of mechanism for different application. | **Unit - I Fundamentals and Types of Mechanism**<br>1.1 Kinematics of Machines: - Definition of statics, Dynamics, Kinematics, Kinetics, Kinematic link and its types, Kinematic pair and its types, constrained motion and its types<br>1.2 Kinematic chain (locked chain, constrained chain and unconstrained chain with equation), Degree of freedom (Kutzbach equation)<br>1.3 Mechanism and Inversion: Mechanism and Inversion of Mechanism, Difference between machine and structure.<br>1.4 Inversion of Kinematic Chain a) Inversion of four bar chain: Beam engine, Coupling rod of Locomotive, Watt's indicator mechanism. b) Inversion of single slider Crank chain: Reciprocating I.C. engine, Whitworth quick return mechanism, Rotary Engine, Oscillating cylinder engine, Crank and slotted lever quick return Mechanism, Hand Pump mechanism c) Inversion of Double Slider Crank Chain: Elliptical trammel, Scotch Yoke Mechanism, Oldham's Coupling | Classroom Lecture<br>Model Demonstration<br>Video Demonstrations<br>Hands-on<br>Presentations |

**THEORY OF MACHINES** **Course Code : 313313**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 2 | TLO 2.1 Describe velocity and acceleration in mechanism.<br>TLO 2.2 Draw velocity and acceleration diagram/polygon by relative velocity/ Klein's construction method following standard procedure .<br>TLO 2.3 Determine linear and angular velocity of links in the given mechanism.<br>TLO 2.4 Determine linear and angular acceleration of links in the given mechanism. | **Unit - II Velocity and Acceleration in Mechanism**<br>2.1 Concept of relative velocity and acceleration of a point on a link, Inter-relation between linear and angular velocity and acceleration.<br>2.2 Drawing of velocity and acceleration diagram of a given configuration, diagrams of simple Mechanisms: four bar chain and single slider crank chain (Limited up to 4 Links).<br>2.3 Determination of velocity and acceleration of point on link by relative velocity method (Excluding Coriolis component of acceleration) .<br>2.4 Klein's construction to identify velocity and acceleration of different links in single slider crank mechanism (When crank rotates with uniform velocity only). | Lecture Using Chalk-Board<br>Video Demonstrations |
| 3 | TLO 3.1 Explain Cam and its terminology with field application.<br>TLO 3.2 Identify the type of motion of Follower.<br>TLO 3.3 Classify Cams and Followers.<br>TLO 3.4 Draw Cam profile as per the given condition of Follower. | **Unit - III Cam and Follower**<br>3.1 Introduction to Cams and Followers, definition and applications of Cams and Followers, Cam terminology.<br>3.2 Classification of Cams and Followers.<br>3.3 Different follower motions and their displacement diagrams - Uniform velocity, simple harmonic motion, uniform acceleration and retardation.<br>3.4 Drawing of profile of radial Cam with knife-edge and roller Follower with and without offset (reciprocating motion only). | Lecture Using Chalk-Board<br>Model Demonstration<br>Video Demonstrations<br>Presentations |
| 4 | TLO 4.1 Identify the different drives for power transmission.<br>TLO 4.2 Select suitable drive for a particular application.<br>TLO 4.3 Calculate various quantities like velocity ratio, belt tensions, angle of contact, power transmitted in belt drives.<br>TLO 4.4 Enlist advantages and disadvantages of chain drive.<br>TLO 4.5 Identify the different types of gear trains.<br>TLO 4.6 Compare belt drive, chain drive and gear drive for given parameters. | **Unit - IV Power transmission (Belt, Chain and Gear)**<br>4.1 Belt Drive: a) Type of belts, flat belt, V-belt & its applications, material for flat and V-belt, Selection of belts b) Angle of lap, length of belt (No derivation), Slip and creep, Determination of velocity ratio of tight side and slack side tension, Power transmitted by belt. (numerical on power transmission by belt)<br>4.2 Chain Drives: Types of chains and sprockets, Advantages & Disadvantages of chain drive over other drives (No numerical on Chain drive).<br>4.3 Gear Drives: a) Classification of gears, Law of gearing, Concept of Conjugate profile (Involute only) Spur gear terminology. b) Types of gear trains, Train value & velocity ratio for simple, compound, reverted and epicyclic gear trains. (No numerical on Gear drive).<br>Comparison between Belt drive, Chain drive and Gear drive | Lecture Using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Model Demonstration |

**THEORY OF MACHINES** **Course Code : 313313**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 5 | TLO 5.1 Explain the concept of balancing.<br>TLO 5.2 Find balancing mass and position of plane analytically and graphically in single plane.<br>TLO 5.3 Explain the basic vibrating system with causes and remedies. | **Unit - V Balancing of Masses and Vibration**<br>5.1 Balancing of Rotating Masses: Concept of balancing: Need and types of balancing, Balancing of single rotating mass.<br>5.2 Analytical and Graphical methods for balancing of several masses revolving in same plane and different plane (Numerical on single plane only).<br>5.3 Vibration: Fundamentals of Vibration: Definition and concept of Free, Forced, Undamped, Damped vibrations. (no numerical)<br>5.4 Advantages and Disadvantages of Vibration, Causes and remedies of Vibration, Vibration isolators. Forced vibrations of longitudinal and torsional systems (Concepts only, No numerical and No derivation on vibration). | Lecture Using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Case Study |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 1.1 Identify different mechanisms available in laboratories/institute premises<br>LLO 1.2 Sketch the identified mechanism. | 1 | Identification of Mechanisms in the different laboratory and institute premises. | 2 | CO1<br>CO3<br>CO4 |
| LLO 2.1 Identify number of links and pairs of given mechanism<br>LLO 2.2 Identify input link and its motion.<br>LLO 2.3 Identify output link and its motion | 2 | *Estimation of kinematic data for mechanism available in the laboratory (any one from Group A and any one from Group B)<br>Group A:<br>i) Beam Engine<br>ii) Coupling rod of Locomotive,<br>iii) Watt's indicator mechanism.<br>Group B:<br>i) Reciprocating engine<br>ii) Whitworth quick return mechanism.<br>iii) Rotary Engine<br>iv) Crank and slotted lever quick return Mechanism<br>v) Hand Pump mechanism | 2 | CO1 |

**THEORY OF MACHINES** **Course Code : 313313**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 3.1 Identify number of links and pairs of given mechanism.<br>LLO 3.2 Identify input link and its motion.<br>LLO 3.3 Identify Output link and its motion. | 3 | Estimation of kinematic data for mechanism available in the laboratory (any one from Group A and any one from Group B)<br>Group A:<br>i) Elliptical trammel,<br>ii) Scotch Yoke Mechanism,<br>iii) Oldham's Coupling<br>Group B:<br>i) Bicycle free wheel sprocket mechanism<br>ii) Geneva mechanism<br>iii) Ackerman's steering gear mechanism<br>iv) Foot operated air pump mechanism | 2 | CO1 |
| LLO 4.1 Determine degree of freedom of given mechanism | 4 | *Degree of Freedom of given mechanism by using Kutzbach equation.<br>(Any five mechanisms available in the Laboratory) | 2 | CO1 |
| LLO 5.1 Measure the ratio of time of cutting stroke to the return stroke in shaping operation. | 5 | *Quick return mechanism used in a shaper machine | 2 | CO1 |
| LLO 6.1 Draw velocity and acceleration polygon of four bar chain.<br>LLO 6.2 Calculate angular velocity and linear velocity of a link using given data. | 6 | Velocity and Acceleration of four bar chain by relative velocity method.<br>(Two Problem on A2 size Sheet.) | 2 | CO2 |
| LLO 7.1 Draw velocity and acceleration polygon of single slider crank chain.<br>LLO 7.2 Calculate angular velocity and linear velocity of a link using given data. | 7 | *Velocity and Acceleration of single slider crank chain by relative velocity method.<br>(Two Problem on A2 size Sheet.) | 2 | CO2 |
| LLO 8.1 Draw a space diagram of a single slider crank mechanism<br>LLO 8.2 Measure the velocity and acceleration of links using Klien's construction method. | 8 | Velocity and Acceleration of Slider crank chain by Klien's Construction Method. | 2 | CO2 |

**THEORY OF MACHINES** **Course Code : 313313**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 9.1 Generate cam profile for given follower to obtain desired follower motion | 9 | Cam profile for knife edge Follower. (Two problem on A2 size sheet, at least one problem on offset follower) | 2 | CO3 |
| LLO 10.1 Generate cam profile for given follower to obtain desired follower motion | 10 | Cam Profile for roller follower. (Two Problem on A2 size sheet, at least one problem on offset follower) | 2 | CO3 |
| LLO 11.1 Identify displacement of follower with cam rotation | 11 | *Measurement of follower displacement with Cam rotation for knife edge follower and roller follower | 2 | CO3 |
| LLO 12.1 Measure the angular speed using tachometer.<br>LLO 12.2 Compute the length of belt and slip | 12 | *Estimation of slip, length of belt, angle of contact in an open and cross belt drive. | 2 | CO4 |
| LLO 13.1 Identify the type of gears and gear train. | 13 | Identification of gears and gear train in Lab and Machine shop. | 2 | CO4 |
| LLO 14.1 Identify the type of gears and gear train.<br>LLO 14.2 Construct gear train for desirable velocity ratio | 14 | *Preparation of different Gear trains from the given gears. | 2 | CO4 |
| LLO 15.1 Construct balanced system for rotating masses. | 15 | *Balancing of rotating unbalanced system | 2 | CO5 |

**Note : Out of above suggestive LLOs -**

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**NA**

- NA

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

**THEORY OF MACHINES** **Course Code : 313313**

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | Working Model of Beam Engine, Coupling rod of Locomotive, Watt's indicator mechanism, Reciprocating engine, Whitworth quick return mechanism, Rotary Engine, Crank and slotted lever quick return Mechanism, Hand Pump mechanism | 1,2,4 |
| 2 | Shaper machine available in institute workshop | 1,2,4,5 |
| 3 | Working Models of Elliptical trammel, Scotch Yoke Mechanism, Oldham's Coupling, Bicycle free wheel sprocket Mechanism, Geneva mechanism, Ackerman's steering gear Mechanism, Foot operated air pump mechanism | 1,3,4 |
| 4 | Working models of Flat belt and V belt arrangement for demonstration | 1,4,12 |
| 5 | Experimental cam follower set up: Machine consist of a cam shaft driven by a D.C. motor/Manual operated. The shaft runs in a double ball bearing. At the free end of the cam shaft a cam can be easily mounted. The follower is properly guided in bushes and the type of the follower can be changed to suit the cam under test. A graduated circular protractor is fitted coaxial with the shaft and a dial gauge can be fitted to note the follower displacement for the angle of cam rotation. A spring is used to provide controlling force to the follower system. | 11 |
| 6 | Tachometer: optical type of tachometer (digital Tachometer) Range speed minimum 0 to 2000RPM or more | 12 |
| 7 | Belt drive test benchA test bench comprising of following pulleys, belts, electrical motor, arrangement for adjusting belt tensions and regulating speed of the driving motor and a suitable mounting frame | 12 |
| 8 | Working Model of Gear Trains: i) Simple Gear Train ii) Compound Gear train iii) Reverted Gear Train iv) epicyclic Gear Train | 13 |
| 9 | Different types of Gears with different modules : al least 5 quantity of each gear Spur gearHelical gear (Single /double)Spiral gearBevel gear | 13 |
| 10 | Experimental set up to arrange gears and shaft such that desired gear train can be obtained for given velocity ratio. | 14 |
| 11 | Static & Dynamic Balancing MachineSingle phase motor connected to a shaft, containing 4 rotating masses. Each rotating masshas a facility to insert. Pulley is provided to add weights to balance the unbalance shaft | 15 |
| 12 | Working models of various Cam follower arrangements for demonstration (Radial cam with knife edge and Roller follower models are mandatory) | 4,9,10,11 |

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | I | Fundamentals and Types of Mechanism | CO1 | 16 | 6 | 8 | 4 | 18 |
| 2 | II | Velocity and Acceleration in Mechanism | CO2 | 10 | 2 | 4 | 6 | 12 |
| 3 | III | Cam and Follower | CO3 | 10 | 4 | 4 | 6 | 14 |
| 4 | IV | Power transmission (Belt, Chain and Gear) | CO4 | 16 | 4 | 8 | 4 | 16 |
| 5 | V | Balancing of Masses and Vibration | CO5 | 8 | 4 | 4 | 2 | 10 |
| **Grand Total** | | | | **60** | **20** | **28** | **22** | **70** |

## X. ASSESSMENT METHODOLOGIES/TOOLS

**THEORY OF MACHINES** **Course Code : 313313**

**Formative assessment (Assessment for Learning)**

- Laboratory Performance and Term work, Class Test I & II
- Term work (Lab Manual and drawing sheet), Question and Answers in class room as well as at the time of Practical. Note: Each practical will be assessed considering 60% and 40 % weightage.

**Summative Assessment (Assessment of Learning)**

- End Semester Board exam- Theory

## XI. SUGGESTED COS - POS MATRIX FORM

| 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 | PSO-3 |
| CO1 | 3 | - | - | 2 | - | - | 2 | | | |
| CO2 | 3 | 2 | 1 | - | - | - | - | | | |
| CO3 | 3 | 2 | 3 | 2 | - | - | 1 | | | |
| CO4 | 3 | 2 | 1 | 2 | 1 | - | 2 | | | |
| CO5 | 3 | 2 | 1 | 2 | 2 | - | 1 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | A. Ghosh, A. K. Malik | Theory Of Mechanisms and Machines | Affiliated East west press ISBN: 978-8185938936 |
| 2 | S. S. Rattan | Theory Of Machines | Tata McGraw Hill Edu. New Delhi, 2010, ISBN: 978-9353166281 |
| 3 | R.S. Khurmi, J. K. Gupta | Theory of Machines | S. Chand and Company New Delhi, ISBN: 978-8121925242 |
| 4 | J. E. Shigely, J. J. Uicker | Theory Of Machines and Mechanisms | Tata McGraw Hill Edu. New Delhi, 2010, ISBN: 978-0198062325 |
| 5 | R. K. Bansal, Brar J. S. | A text book of Theory of Machine | Khanna Book Publishing CO(P) LTD, New Delhi, ISBN: 9788170084181 |
| 6 | P. L. Ballaney | Theory Of Machines | Khanna Book Publishing CO(P) LTD, New Delhi, ISBN: 978-8174091222 |
| 7 | Sadhu Singh | Theory of Machines | Pearson Education ISBN: 978-8131760697 |
| 8 | S.S. Rao | Mechanical Vibrations | Pearson Education 2018 ISBN: 978-9353062569 |
| 9 | G.K. Grover | Mechanical Vibration | 978-8185240565 |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | http://www.mechanalyzer.com/downloads.html | Mech Analyzer is a free software developed to simulate and analyze the mechanisms |
| 2 | https://www.youtube.com/watch?v=oTcC_xXfdrA | Coupling Rod Locomotive |
| 3 | https://www.youtube.com/watch?v=8shK6kbu7Xk | Piston cylinder animation showing application of cam and gear train |
| 4 | https://www.youtube.com/watch?v=yHHeicPbEzg | Simple Beam Engine |
| 5 | https://www.youtube.com/watch?v=yHHeicPbEzg | Knife edge follower and Radial Cam |
| 6 | https://www.youtube.com/watch?v=Rib-_ZK8KfE | Roller follower with Radial Cam |
| 7 | https://www.youtube.com/watch?v=AODiJYtxuSw | Grear train animation |
| 8 | https://www.youtube.com/watch?v=klVYeSlxucU | Types of Belt drives |
| 9 | https://www.udemy.com/course/theory-of-machines-determine-degrees-of-freedom-in-a-system/ | Degree of freedom |
| 10 | https://archive.nptel.ac.in/courses/112/106/112106270/ | Online NPTL lectures of Theory of machine |
| 11 | https://play.google.com/store/apps/details?id=com.pinjara_imran5290.Belt_Length_Calculator&hl=en&gl=US&pli=1 | Belt length calculator Application (play store app) |
| 12 | https://psmotion.com/mechdesigner/feature/cam-design-analysis | Design of Cam software |
| 13 | https://www.vlab.co.in/broad-area-mechanical-engineering | Virtual Lab |
| 14 | https://opac.library.iitb.ac.in/ | Digital Central Library |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**CONTROL SYSTEMS** **Course Code : 314337**

**Programme Name/s : Mechatronics**
**Programme Code : MK**
**Semester : Fourth**
**Course Title : CONTROL SYSTEMS**
**Course Code : 314337**

## I. RATIONALE

Control systems aims to maintain desired outputs or conditions by adjusting inputs which ensures that a system behaves in a predictable and desired manner. As a result, the control systems are widely gaining importance in industrial automation, production, robotics, and many other fields. This course will facilitate students to understand and apply the concepts, principles, and procedures of controlling various parameters in different processes used in industry as well as day to day life.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain the mechatronics control systems in industrial applications.

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Interpret the type of control system.
- CO2 - Analyse the given control system for standard test input signal.
- CO3 - Examine the stability of given control system.
- CO4 - Use different control action for controlling various processes.
- CO5 - Maintain different servo system components in industrial applications.

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | Total Marks |
| | | | | | | | | | | | | | | | Practical | | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 314337 | CONTROL SYSTEMS | CSS | DSC | 3 | - | 2 | 1 | 6 | 3 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | - | - | 25 | 10 | 150 |

**CONTROL SYSTEMS** **Course Code : 314337**

**Total IKS Hrs for Sem. :** 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 Identify the given control system.<br>TLO 1.2 Distinguish between the different types of control system.<br>TLO 1.3 Determine transfer function of given control system.<br>TLO 1.4 Optimize the transfer function of given system using block diagram reduction rules. | **Unit - I Overview of Control Systems**<br>1.1 Control System: Definition, block diagram<br>1.2 Types of Control System a) Open loop system: Block diagram, working, examples b) Closed loop system: Block diagram, working, examples c) Linear and Nonlinear system: Definition, examples d) Time Variant System and Invariant system: Definition, examples<br>1.3 Transfer Function: Definition, Transfer function of electrical circuits (RL, RC, LC & RLC circuits) using Laplace Transform<br>1.4 Block diagram reduction technique: Need, block diagram reduction rules, and numericals | Demonstration<br>Lecture using Chalk-Board |
| 2 | TLO 2.1 Interpret time response of given control system.<br>TLO 2.2 List the standard test input along with their laplace transform.<br>TLO 2.3 Interpret time response of first order control system.<br>TLO 2.4 Draw a labelled time response of second order system. | **Unit - II Time Domain Analysis**<br>2.1 Time Domain Analysis: Transient and steady state response. concept of poles, zeros, characteristics equation, order of system with numericals<br>2.2 Standard Test Inputs: Step, ramp, parabolic and impulse input (mathematical equation, response and their transfer function)<br>2.3 First Order System: Analysis for unit step input and their response<br>2.4 Second Order System: For unit step input (no derivation) and their response, effect of damping on system stability<br>2.5 Time Response Specifications: Peak time, rise time, settling time, delay time, peak overshoot (no derivation) and numericals | Lecture using Chalk-Board<br>Hands-on<br>Collaborative learning |

**CONTROL SYSTEMS** **Course Code : 314337**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 3 | TLO 3.1 List the types of system based on stability.<br>TLO 3.2 Determine stability based on the location of poles in S-plane.<br>TLO 3.3 Examine stability by using Routh's criterion.<br>TLO 3.4 Determine the range of 'k' for conditionally stable system. | **Unit - III Stability Analysis**<br>3.1 Stability: Definition, types of system based on stability<br>3.2 Types of Stability: Absolute and Relative Stability. Stability analysis using location of poles in S-plane<br>3.3 Routh's Stability Criterion: Routh's array, statement, special cases. Stability analysis using Routh Array<br>3.4 Application of Routh's criterion: Determination of 'K' for conditional stability | Lecture using Chalk-Board<br>Case Study<br>Hands-on |
| 4 | TLO 4.1 Explain process control system with labelled diagram.<br>TLO 4.2 Classify different control actions.<br>TLO 4.3 Compare different control action modes on the basis of its different parameters. | **Unit - IV Process Controllers and Control Actions**<br>4.1 Process Control System: Block diagram, working<br>4.2 Control Action Mode: Definition, classifications<br>4.3 Discontinuous Mode: ON-OFF control action mode, output equation, operation, Neutral zone<br>4.4 Continuous Mode: Proportional, Integral, Derivative control actions (output equations, operation, responses and their applications only)<br>4.5 Composite Control Actions: a) PI Control action b) PD control action c) PID control action (output equation, operation and their responses only) | Lecture using Chalk-Board<br>Case Study<br>Demonstration |
| 5 | TLO 5.1 Describe the function of servo system along with its importance in control system.<br>TLO 5.2 Describe working of different servo components for using as an error detector.<br>TLO 5.3 Differentiate between AC servomotor, DC servomotor and stepper motor.<br>TLO 5.4 Differentiate between AC and DC position control system. | **Unit - V Servo Systems and Components**<br>5.1 Servo System: Definition, block diagram, working<br>5.2 Servo Components: a) Potentiometer: construction, working, potentiometer as an error detector b) Synchro: construction, working, synchro as an error detector c) Rotary encoder: types, working, applications<br>5.3 Servo Motors: a) Servo motor: types, working, applications b) Stepper motor: types, working, applications<br>5.4 Position Control Systems: a) AC position control: block diagram and working b) DC position control: block diagram and working | Lecture using Chalk-Board<br>Collaborative learning<br>Demonstration |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 1.1 Identify open loop system available in laboratory.<br>LLO 1.2 Demonstrate the working of open loop system available in laboratory. | 1 | Interpretation of open loop control system using traffic light controller or any open loop system available in laboratory | 2 | CO1 |

**CONTROL SYSTEMS** **Course Code : 314337**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 2.1 Identify closed loop system available in laboratory.<br>LLO 2.2 Measure the various parameters for the closed loop temperature control system available in laboratory. | 2 | * Interpretation of close loop control system using temperature control system | 2 | CO1 |
| LLO 3.1 Identify any open source software for control system.<br>LLO 3.2 Implement given system using identified software. | 3 | Determination of transfer function and order of given system by using open-source or any other software | 2 | CO1 |
| LLO 4.1 Implement given system using the open source software to identify poles and zeros. | 4 | Determination of poles and zeros of given transfer function by using open-source or any other software | 2 | CO2 |
| LLO 5.1 Identify order of given control system.<br>LLO 5.2 Verify the time response of identified system for standard test inputs. | 5 | * Interpretation of response of first order R-C circuit for the different standard inputs (any relevant software may also be used for implementation) | 2 | CO2 |
| LLO 6.1 Identify order of given control system.<br>LLO 6.2 Verify the time response of identified system for standard test inputs. | 6 | Interpretation of response of second order R-L-C circuit for the different standard inputs (any relevant software may also be used for implementation) | 2 | CO2 |
| LLO 7.1 Determine the stability of given system using Routh’s stability criteria. | 7 | * Verification of Routh’s stability criteria of given control system by using open-source or any other software | 2 | CO3 |
| LLO 8.1 Find the range of 'K' for conditionally stable system using Routh's criteria. | 8 | Determination of range of ‘K’ for deciding conditional stability of given control system using Routh's criteria | 2 | CO3 |
| LLO 9.1 Identify the type of controller for given experiment.<br>LLO 9.2 Verify the response of identified controller in the laboratory. | 9 | * Interpretation of characteristics of P/PI/PD controller for controlling the given process. (Any relevant software may also be used for implementation) | 2 | CO3 |
| LLO 10.1 Identify the type of controller for given experiment.<br>LLO 10.2 Verify the response of the PID controller. | 10 | * Interpretation of characteristics of PID controller for controlling the given process. (Any relevant software may also be used for implementation) | 2 | CO4 |
| LLO 11.1 Connect potentiometers for using as an error detector.<br>LLO 11.2 Determine the differential voltage between potentiometers. | 11 | * Interpretation of characteristics of potentiometer as an error detector | 2 | CO5 |
| LLO 12.1 Use synchro as an error detector.<br>LLO 12.2 Calculate the error voltage between potentiometers. | 12 | *Interpretation of characteristics of synchro as an error detector | 2 | CO5 |

**CONTROL SYSTEMS** **Course Code : 314337**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 13.1 Use AC servo system for position control.<br>LLO 13.2 Calculate the angular position control of AC servo system. | 13 | * Determination of angular position of AC servo system | 2 | CO5 |
| LLO 14.1 Use DC servo system for position control.<br>LLO 14.2 Calculate the angular position control of DC servo system. | 14 | Determination of angular position of DC servo system | 2 | CO5 |
| LLO 15.1 Use Stepper motor as servo component.<br>LLO 15.2 Count the pulses of stepper motor required to complete one rotation. | 15 | Using stepper motor as servo system component for position control system | 2 | CO5 |

**Note : Out of above suggestive LLOs -**

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**Activities**

- Prepare a chart on comparison of different control actions in control system
- Prepare a chart of standard test inputs used in control system and steady state errors for given standard test inputs. Prepare a brief presentation along with report on it
- Prepare a chart of rules for block diagram reduction techniques and prepare a brief presentation along with report on it
- Perform market survey for availability of different servo components and prepare a report
- Perform simulation on any open source Virtual Labs on following topics and write a report on it a. Temperature control system b. Two Tank Water Level control c. Study of DC Motor d. Study and operation of the DC Speed and Position control setup e. Simulation of Control Systems

**Micro project**

- Simulate On-Off temperature and flow control loop system using process control simulator
- Build/ Test Potentiometer as an error detector
- Survey or Visit automation industry using PLC/SCADA/DCS/HMI system and prepare detailed report on it
- Build/ Test an automatic feedback temperature control system
- Build/ Test an automatic feedback water level control system
- Build/ Test an RC circuit and check its output response
- Build/ Test an RLC circuit and check its output response
- Prepare a report of Simulation on PI -control action on a given system for given step input and set point. Obtain the effect on output varying Kp, Ki, Kd of the system
- Prepare a report of Simulation on PD-control action on a given system for given step input and set point. Obtain the effect on output varying Kp, Ki, Kd of the system

**Assignment**

**CONTROL SYSTEMS** **Course Code : 314337**

- Identify and classify the control systems available in control system laboratory
- Prepare a report and presentation on stability analysis based on special cases

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | Traffic Light control system setup with red, yellow and green lights | 1 |
| 2 | Potentiometer as an error detector trainer kit | 11 |
| 3 | Characteristics of synchro Transmitter | 12 |
| 4 | AC Position control system | 13 |
| 5 | DC Position control system | 14 |
| 6 | Stepper motor trainer kit | 15 |
| 7 | ON-OFF controller: Heater, Temperature sensor and Relay | 2 |
| 8 | Softwares like SCILAB or MATLAB or MULTISIM or NI | 3,4,5,6,7,8,9,10 |
| 9 | Standard test signal generator kit : Step, Ramp and Parabolic signals. 1) First Order trainer 2) Second order trainer | 5,6 |
| 10 | Proportional PI, PD, PID controller and control system setup with ON-OFF Temperature control using PID Trainer | 9,10 |
| 11 | Cathode ray oscilloscope: Dual trace 50MHz | All |
| 12 | Multimeter 3 1/2 Digit: AC/DC, 0-200 V | All |

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | I | Overview of Control Systems | CO1 | 10 | 4 | 4 | 6 | 14 |
| 2 | II | Time Domain Analysis | CO2 | 11 | 4 | 4 | 8 | 16 |
| 3 | III | Stability Analysis | CO3 | 10 | 4 | 4 | 6 | 14 |
| 4 | IV | Process Controllers and Control Actions | CO4 | 6 | 2 | 4 | 4 | 10 |
| 5 | V | Servo Systems and Components | CO5 | 8 | 4 | 6 | 6 | 16 |
| **Grand Total** | | | | **45** | **18** | **22** | **30** | **70** |

## X. ASSESSMENT METHODOLOGIES/TOOLS

**CONTROL SYSTEMS** **Course Code : 314337**

**Formative assessment (Assessment for Learning)**

- Continuous assessment based on process and product related performance indicators. Each practical will be assessed considering: -60% weightage to process -40% weightage to product

**Summative Assessment (Assessment of Learning)**

- End of Term Examination (Theory)

## XI. SUGGESTED COS - POS MATRIX FORM

| 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 | PSO-3 |
| CO1 | 3 | 3 | 3 | 3 | - | - | 2 | | | |
| CO2 | 3 | 3 | 3 | 3 | - | - | 2 | | | |
| CO3 | 3 | 3 | 3 | - | - | - | 2 | | | |
| CO4 | 3 | - | - | 3 | 2 | 2 | 3 | | | |
| CO5 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | I. J. Nagrath & M. Gopal | Control System Engineering | New Age International Publishers, 2021, ISBN: 978-8195175581 |
| 2 | K. Ogata | Modern Control Engineering | PHI, New Delhi (5th Edition), 2008, ISBN: 978-8131703118 |
| 3 | C. D. Johnson | Process Control Instrumentation Technology | PHI Learning, 2015, ISBN: 978-9332549456 |
| 4 | A. Anand Kumar | Control Systems | PHI (2nd Edition), 2014, ISBN: 978-8120349391 |
| 5 | K.P. Ramchandran | Control Engineering | Willey India, Delhi, 2011 , ISBN: 978-8126522880, |
| 6 | Rajeev Gupta | Control System Engineering | NISE's, Willey India, 2018 ISBN: 8126571837 |
| 7 | S.P. Eugene Xavier, Joseph Cyril Babu, J. | Principles of Control System | S. Chand, New Delhi, 2004, ISBN: 978-8121917780 |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm | Control Systems - Introduction |
| 2 | https://www.tutorialspoint.com/control_systems/control_systems_quick_guide.htm | Control Systems - Quick Guide |
| 3 | https://www.tutorialspoint.com/control_systems/control_systems_feedback.htm | Control Systems - Feedback |
| 4 | https://www.tutorialspoint.com/control_systems/control_systems_mathematical_models.htm | Control Systems - Mathematical Models |
| 5 | https://www.tutorialspoint.com/control_systems/control_systems_block_diagrams.htm | Control Systems - Block Diagrams |
| 6 | https://www.tutorialspoint.com/control_systems/control_systems_time_domain_specifications.htm | Time Domain Specifications |
| 7 | https://electronicscoach.com/time-domain-analysis-of-control-system.html | Time Domain Analysis of Control System |
| 8 | https://www.tutorialspoint.com/control_systems/control_systems_stability.htm | Control Systems - Stability |
| 9 | https://www.tutorialspoint.com/control_systems/control_systems_controllers.htm | Control Systems - Controllers |
| 10 | https://www.electrical4u.com/types-of-controllers-proportional-integral-derivative-controllers/ | Types of controllers |
| 11 | https://en.wikipedia.org/wiki/Servomechanism | Servo Systems |
| 12 | https://www.utmel.com/blog/categories/motors/introduction-to-servo-system | Servo Systems |
| 13 | https://www.scilab.org | SCILAB Software |
| 14 | https://www.mathworks.com/products/matlab.html | MATLAB Software |
| 15 | https://www.multisim.com | Multisim Software |
| 16 | https://www.youtube.com/watch?v=ApMz1-MK9IQ | MATLAB Practice |
| 17 | http://vlabs.iitkgp.ac.in/gps/ctrl/index.html | Virtual Labs |
| 18 | https://www.ni.com/en/support/downloads/software-products/download.multisim.html | NI MULTISIM Software |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

**Programme Name/s : Mechatronics**
**Programme Code : MK**
**Semester : Fourth**
**Course Title : EMBEDDED SYSTEM USING 'C'**
**Course Code : 314338**

## I. RATIONALE

Embedded system has become an integral part of various mechatronics systems such as robotics, industrial automation, smart appliances etc. This course will make students proficient and enable them to develop and maintain various embedded systems.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Develop various embedded system applications in mechatronics.

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Classify the different types of embedded systems.
- CO2 - Use embedded ‘C’ language for programming 8051 microcontroller.
- CO3 - Interpret the communication protocols of embedded systems.
- CO4 - Develop embedded ‘C’ programs for Input/Output devices.
- CO5 - Develop basic embedded system applications.

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | Total Marks |
| | | | | | | | | | | | | | | | Practical | | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 314338 | EMBEDDED SYSTEM USING 'C' | ESC | AEC | 3 | - | 4 | 1 | 8 | 4 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | - | - | 25 | 10 | 150 |

**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

**Total IKS Hrs for Sem. :** 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 Explain the block diagram of embedded system with it's characteristics.<br>TLO 1.2 Classify the Embedded Systems.<br>TLO 1.3 Distinguish between Von-Neumann and Harvard architecture.<br>TLO 1.4 Explain the features and pin configuration of 8051 microcontroller.<br>TLO 1.5 Explain power-saving options of 8051. | **Unit - I Overview of Embedded System**<br>1.1 Block diagram of embedded system with hardware components<br>1.2 Characteristics of Embedded System: Processor power, memory, operating system, reliability, performance, power consumption, NRE cost, unit cost, size, flexibility, time-to prototype, time-to-market, maintainability, correctness and safety<br>1.3 Classification of Embedded System: Small scale, medium scale, sophisticated, stand-alone, reactive /real time (soft and hard real time)<br>1.4 Von-Neumann and Harvard architecture<br>1.5 8051 microcontroller: Features, pin configuration<br>1.6 8051 as a Boolean processor, Power-saving options- Idle and power down mode | Lecture using Chalk-Board Presentations Video Demonstrations |
| 2 | TLO 2.1 List the various datatypes in Embedded 'C'.<br>TLO 2.2 Develop embedded 'C' program for arithmetic, logical and data transfer operations.<br>TLO 2.3 Develop embedded 'C' program using timer.<br>TLO 2.4 Develop embedded 'C' program for serial transmission and reception.<br>TLO 2.5 Explain the 8051 interrupts. | **Unit - II 8051 Programming using Embedded 'C'**<br>2.1 Embedded C: Data types, decision control and looping<br>2.2 8051 Microcontroller programming in embedded C: Arithmetic and logical operations, data transfer on Input/ Output ports<br>2.3 Timer/Counters: TMOD,TCON, Timer/Counter modes and 'C' programs for Timer/Counter<br>2.4 Serial communication: SCON, SBUF, modes of serial communication, 'C' programs for serial communication<br>2.5 Interrupts: 8051 interrupts, IE and IP SFRs | Lecture using Chalk-Board Presentations Video Demonstrations |

**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 3 | TLO 3.1 Compare serial vs. parallel communication and synchronous vs. asynchronous communication.<br>TLO 3.2 Explain the serial communication protocol.<br>TLO 3.3 Describe the important features of advanced serial protocols. | **Unit - III Communication Standards and Protocols**<br>3.1 Modes of data communication: Serial, parallel, synchronous and asynchronous communication<br>3.2 Serial communication standard RS232 (DB9)<br>3.3 Serial communication protocols: I2C, CAN, Serial Peripheral Interface (SPI)<br>3.4 Features of advanced serial protocols: IrDA, Bluetooth, Zigbee | Lecture using Chalk-Board<br>Presentations<br>Video Demonstrations |
| 4 | TLO 4.1 Develop ‘C’ program for interfacing switch and LED.<br>TLO 4.2 Develop ‘C’ program for interfacing a relay.<br>TLO 4.3 Develop ‘C’ program for interfacing 7-segment LED display.<br>TLO 4.4 Explain interfacing of 16X2 LCD with 8051.<br>TLO 4.5 Explain interfacing of ADC 0808 with 8051.<br>TLO 4.6 Develop 'C' program for generating square wave and triangular wave. | **Unit - IV Interfacing of Input and Output Devices with 8051**<br>4.1 Interfacing of switch, LED and it’s programming in ‘C’<br>4.2 Interfacing of relay and it’s programming in ‘C’<br>4.3 Interfacing and ‘C’ programming of single 7-segment LED display<br>4.4 16 x 2 LCD interfacing with 8051 and it’s programming in ‘C’<br>4.5 Interfacing of ADC 0808. ‘C’ program to convert analog signal into digital<br>4.6 Interfacing of DAC 0808 and ‘C’ program to generate square wave and triangular wave | Lecture using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Demonstration |
| 5 | TLO 5.1 Develop ‘C’ program for rotating DC motor and servo motor interfaced with 8051.<br>TLO 5.2 Develop ‘C’ program for rotating stepper motor in clockwise and anticlockwise direction.<br>TLO 5.3 Develop ‘C’ program for obstacle detection using IR sensor.<br>TLO 5.4 Develop ‘C’ program for motion detection using PIR sensor. | **Unit - V Applications of 8051 Microcontroller**<br>5.1 Interfacing of DC motor and servo motor, it’s programming in ‘C’<br>5.2 Interfacing of stepper motor and ‘C’ program to rotate the stepper motor<br>5.3 Interfacing of IR sensor and simple ‘C’ program for obstacle detection<br>5.4 Interfacing of PIR sensor and simple 'C' program for motion detection | Lecture using Chalk-Board<br>Presentations<br>Video Demonstrations<br>Demonstration |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 1.1 Identify various blocks of 8051 microcontroller development board.<br>LLO 1.2 Connect the development board to PC. | 1 | *Identification of various blocks of 8051 microcontroller development board | 2 | CO1 |

**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 2.1 Install Integrated Development Environment (IDE) tool for 8051 microcontroller.<br>LLO 2.2 Use IDE tool. | 2 | *Integrated Development Environment tool for 8051 microcontroller | 2 | CO2 |
| LLO 3.1 Develop C program for input/output operation over port pins.<br>LLO 3.2 Simulate the program. | 3 | *Development of embedded 'C' program to accept data from P1 pins and send it out on P2 pins | 2 | CO2 |
| LLO 4.1 Develop C program for various arithmetic operations.<br>LLO 4.2 Simulate the program for arithmetic operations. | 4 | *Development of embedded 'C' program for various arithmetic operations | 2 | CO2 |
| LLO 5.1 Develop ‘C’ program for various logical operations.<br>LLO 5.2 Simulate the program for logical operations. | 5 | Development of embedded ‘C’ program for various logical operations | 2 | CO2 |
| LLO 6.1 Develop ‘C’ program for port operations.<br>LLO 6.2 Simulate the program port operations. | 6 | Development of embedded ‘C’ program to accept number from P1 and P2 pins and send out greater number on P3 pins | 2 | CO2 |
| LLO 7.1 Develop ‘C’ program for block transfer.<br>LLO 7.2 Simulate the program for block transfer. | 7 | *Development of embedded ‘C’ program for block transfer | 2 | CO2 |
| LLO 8.1 Develop ‘C’ program for generation of square wave without using timer over port pin.<br>LLO 8.2 Simulate the program for square wave generation. | 8 | Development of embedded ‘C’ program for generation of square wave over port pin without using timer | 2 | CO2 |
| LLO 9.1 Develop ‘C’ program for generation of square wave using timer over port pin.<br>LLO 9.2 Simulate the program for square wave generation. | 9 | *Development of embedded ‘C’ program for square wave generation over port pin using 8051 timer | 2 | CO2 |
| LLO 10.1 Develop ‘C’ program to transmit a character ‘Y’ on TxD pin.<br>LLO 10.2 Simulate the program for transmitting a character. | 10 | Development of C program to transmit a character ‘Y’ on TxD pin | 2 | CO2 |
| LLO 11.1 Develop ‘C’ program for transmitting the message.<br>LLO 11.2 Simulate the program for transmitting the message. | 11 | *Development of ‘C’ program for transmitting the message "WELCOME" on serial port | 2 | CO2 |
| LLO 12.1 Identify the pins of DB9 connector.<br>LLO 12.2 Connect DB9 connector to PC using MAX232 IC. | 12 | *Interfacing of RS232 ( DB9) connector to PC using MAX232 IC | 2 | CO3 |

**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 13.1 Develop 'C' program for LED blinking.<br>LLO 13.2 Execute the above program to demonstrate on hardware. | 13 | Interfacing of LED with 8051 and development of 'C' program for LED blinking | 2 | CO4 |
| LLO 14.1 Develop 'C' program to turn ON the LED by pressing a switch.<br>LLO 14.2 Execute the above program to demonstrate on hardware. | 14 | *Development of 'C' program for turning ON the LED by pressing a switch | 2 | CO4 |
| LLO 15.1 Develop 'C' program for toggling 8 LEDs.<br>LLO 15.2 Execute the above program to demonstrate on hardware. | 15 | Interfacing of eight LEDs with 8051 and development of 'C' program for toggling them continuously | 2 | CO4 |
| LLO 16.1 Develop 'C' program for controlling a lamp interfaced with 8051 microcontroller through a relay.<br>LLO 16.2 Execute the above program to demonstrate on hardware. | 16 | *Development of 'C' program for controlling a lamp interfaced with 8051 microcontroller through a relay | 2 | CO4 |
| LLO 17.1 Develop 'C' program for 7-segment LED display.<br>LLO 17.2 Execute the above program to demonstrate on hardware. | 17 | *Development of 'C' program for single digit up- counter (0-9) using 7-segment LED display | 2 | CO4 |
| LLO 18.1 Develop 'C' program for 7-segment LED display.<br>LLO 18.2 Execute the above program to demonstrate on hardware. | 18 | Development of 'C' program to display characters 'A','B','C','D','E','F' on 7-segment LED display | 2 | CO4 |
| LLO 19.1 Develop 'C' program for displaying a message on the 16 x 2 LCD.<br>LLO 19.2 Execute the above program to demonstrate on hardware. | 19 | *Development of 'C' program for displaying a message "Welcome" on the 16 x 2 LCD | 2 | CO4 |
| LLO 20.1 Develop 'C' program to check the occurrence of an external interrupt 0.<br>LLO 20.2 Execute the above program to demonstrate on hardware. | 20 | Development of 'C' program to turn 'ON' the LED when an external interrupt 0 occurs | 2 | CO4 |
| LLO 21.1 Develop 'C' program for square waveform generation using DAC.<br>LLO 21.2 Execute the above program to demonstrate on hardware. | 21 | *Development of 'C' program for generation of square waveform using DAC | 2 | CO4 |
| LLO 22.1 Develop 'C' program for triangular waveform generation using DAC.<br>LLO 22.2 Execute the above program to demonstrate on hardware. | 22 | Development of 'C' program for generation of triangular waveform using DAC | 2 | CO4 |

**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 23.1 Develop 'C' program for ADC.<br>LLO 23.2 Execute the above program to demonstrate on hardware. | 23 | Development of 'C' program for converting the analog signal into digital form using an ADC | 2 | CO4 |
| LLO 24.1 Develop 'C' program for DC motor to rotate the motor in clockwise direction.<br>LLO 24.2 Execute the above program to demonstrate on hardware. | 24 | *Development of 'C' program to rotate the DC motor in clockwise direction | 2 | CO5 |
| LLO 25.1 Develop 'C' program for DC motor to rotate in anticlockwise direction.<br>LLO 25.2 Execute the above program to demonstrate on hardware. | 25 | Development of 'C' program to rotate the DC motor in anticlockwise direction | 2 | CO5 |
| LLO 26.1 Develop 'C' program for stepper motor to rotate in clockwise and anticlockwise direction.<br>LLO 26.2 Execute the above program to demonstrate on hardware. | 26 | Development of 'C' program to rotate the stepper motor in clockwise and anticlockwise direction | 2 | CO5 |
| LLO 27.1 Develop 'C' program to rotate the stepper motor by 180 degrees.<br>LLO 27.2 Execute the above program to demonstrate on hardware. | 27 | *Development of 'C' program to rotate the stepper motor by 180 degrees | 2 | CO5 |
| LLO 28.1 Develop 'C' program to rotate servo motor by specified angle.<br>LLO 28.2 Execute the above program to demonstrate on hardware. | 28 | Development of 'C' program for rotating the servo motor by specified angle | 2 | CO5 |
| LLO 29.1 Develop 'C' program for IR sensor.<br>LLO 29.2 Execute the above program to demonstrate on hardware. | 29 | *Development of 'C' program to turn on the LED when an obstacle is detected by IR sensor | 2 | CO5 |
| LLO 30.1 Develop 'C' program for PIR sensor.<br>LLO 30.2 Execute the above program to demonstrate on hardware. | 30 | Development of 'C' program to turn on the LED when motion is detected by PIR sensor | 2 | CO5 |

**Note : Out of above suggestive LLOs -**

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**Micro project**

- Build a circuit to blink LEDs in different patterns.
- Build 8051 based system for speed control of DC motor.

- Build a circuit using LCD to display name in rolling fashion.
- Build 8051 based product counter.
- Build an automated door controlled system.
- Build a countdown timer using LED 7-segment display.

**Activities**

- Prepare a report on different sensors used in mechatronics industry.
- Write a report on different types of robots.
- Conduct an internet survey on different Arduino boards and prepare a report on it.
- Prepare a report on different motors used in mechatronics industry.
- Prepare a chart on applications of embedded system in mechatronics.

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | 8051 Microcontroller Development Board-single board system with 8K RAM, ROM/Flash memory with battery backup, 16x2 LCD display, RS-232/USB interfacing facility with built in power supply | 1,12,13,14,15,17,18,19,20,21,22,23,24,25,26,27,28,29,30 |
| 2 | LED | 13,14,15,20,29,30 |
| 3 | Switch | 14,20 |
| 4 | +5V Relay | 16 |
| 5 | 7-Segment LED display | 17,18 |
| 6 | 16 x 2 LCD Module | 19 |
| 7 | DAC 0808/0809 Module, CRO- Bandwidth AC 10Hz ~20MHz, DC ~20MHz | 21,22 |
| 8 | ADC 0808/0809 Module | 23 |
| 9 | +5V DC motor with driver | 24,25 |
| 10 | +5V stepper motor with driver | 26,27 |
| 11 | Servo motor: +5V, Torque: 2.5kg/cm, Rotation : 0°-180° | 28 |
| 12 | IR sensor Module | 29 |
| 13 | PIR sensor Module | 30 |
| 14 | PC with IDE and program uploading software for 8051 | All |

**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | I | Overview of Embedded System | CO1 | 8 | 4 | 4 | 6 | 14 |
| 2 | II | 8051 Programming using Embedded 'C' | CO2 | 14 | 4 | 6 | 8 | 18 |
| 3 | III | Communication Standards and Protocols | CO3 | 6 | 2 | 4 | 4 | 10 |
| 4 | IV | Interfacing of Input and Output Devices with 8051 | CO4 | 11 | 4 | 6 | 6 | 16 |
| 5 | V | Applications of 8051 Microcontroller | CO5 | 6 | 2 | 4 | 6 | 12 |
| **Grand Total** | | | | **45** | **16** | **24** | **30** | **70** |

## X. ASSESSMENT METHODOLOGIES/TOOLS

**Formative assessment (Assessment for Learning)**

- FA-TH represents average of two class tests of 30 marks each. FA-PR represents continuous assessment based on process and product related performance indicators. Each practical will be assessed considering 60% weightage to process 40% weightage to product.

**Summative Assessment (Assessment of Learning)**

- End semester theory examination of 70 marks

## XI. SUGGESTED COS - POS MATRIX FORM

| 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 | PSO-3 |
| CO1 | 2 | 2 | 1 | - | 1 | 1 | 2 | | | |
| CO2 | 2 | 3 | 2 | 2 | 1 | 1 | 2 | | | |
| CO3 | 2 | 1 | 1 | 1 | 1 | 1 | 2 | | | |
| CO4 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | | | |
| CO5 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay | The 8051 Microcontroller and Embedded Systems using Assembly and 'C' | Pearson, 2007 ISBN -13: 978-0199681273 |
| 2 | Kenneth J. Ayala | The 8051 Microcontroller: Architecture, Programming and Applications | Penram International Publishing, 1996 ISBN -13: 978-0314201881 |
| 3 | Raj Kamal | Embedded Systems | McGraw Hill, 4th Edition, 2020 ISBN -13: 978-9353168025 |
| 4 | Ajit Pal | Microcontrollers: Principles and Applications | PHI Learning Pvt. Ltd.,2011 ISBN -13: 978-8120343924 |
| 5 | Ajay V. Deshmukh | Microcontrollers: Theory and Applications | McGraw-Hill Education (India) Pvt. Ltd., 2005 ISBN - 13: 978-0070585959 |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | https://www.keil.com/demo/eval/c51.htm | Keil IDE download |
| 2 | https://www.engineersgarage.com/timers-8051-timer-programming/ | 8051 timer programming |
| 3 | https://www.tutorialspoint.com/embedded_systems/es_io_programming.htm | 8051 I/O programmming |
| 4 | https://electrosome.com/interfacing-relay-8051-keil-c/ | Relay interfacing and programming |
| 5 | https://www.javatpoint.com/embedded-system-7-segment-display | 7-segment-display interfacing and programming |
| 6 | https://www.javatpoint.com/embedded-system-lcd-programmming | LCD interfacing and programming |
| 7 | https://www.elprocus.com/embedded-system-programming-using-keil-c-language/ | Embedded 'C' programming |
| 8 | https://www.electronicwings.com/8051/dc-motor-interfacing-with-8051 | DC-motor-interfacing-with-8051 |
| 9 | https://electrosome.com/interfacing-stepper-motor-8051-keil-c-at89c51/ | stepper motor interfacing and programming |
| 10 | https://circuitdigest.com/microcontroller-projects/servo-motor-interfacing-with-8051 | Servo motor interfacing and programming |
| 11 | https://embetronicx.com/tutorials/microcontrollers/8051/ir-sensor-interfacing-with-8051/ | IR sensor interfacing and programming |
| 12 | https://www.electronicwings.com/8051/pir-motion-sensor-interface-with-8051 | PIR sensor interfacing and programming |
| 13 | http://vlabs.iitkgp.ac.in/rtes/index.html | Virtual Lab. for embedded system |

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**EMBEDDED SYSTEM USING 'C'** **Course Code : 314338**

| Sr.No | Link / Portal | Description |
|---|---|---|

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**MSBTE Approval Dt. 21/11/2024** **Semester - 4, K Scheme**

**FLUID POWER AND INDUSTRIAL AUTOMATION** **Course Code : 314339**

**Programme Name/s : Mechatronics**
**Programme Code : MK**
**Semester : Fourth**
**Course Title : FLUID POWER AND INDUSTRIAL AUTOMATION**
**Course Code : 314339**

## I. RATIONALE

The diploma engineer has to use various fluid power operated machines and equipment in different industries. This course will impart knowledge and skills to select appropriate hydraulic and pneumatic system components in the context of industrial automation.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply knowledge and skills of hydraulics and pneumatics system for industrial automation and other applications.

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use fundamentals of fluid power in hydraulic and pneumatic systems.
- CO2 - Select pump/compressor and accessories for given fluid operated system.
- CO3 - Select valves and actuators for given fluid operated system.
- CO4 - Develop various hydraulic / pneumatic circuits for specified application
- CO5 - Construct simple automated hydraulic / pneumatic circuits.

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | Total Marks |
| | | | | | | | | | | | | | | | Practical | | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | | |
| 314339 | FLUID POWER AND INDUSTRIAL AUTOMATION | IAU | DSC | 3 | - | 2 | 1 | 6 | 3 | 3 | 30 | 70 | 100 | 40 | 25 | 10 | 25# | 10 | 25 | 10 | 175 | |

**FLUID POWER AND INDUSTRIAL AUTOMATION** **Course Code : 314339**

**Total IKS Hrs for Sem. :** 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 State properties of fluids<br>TLO 1.2 Describe Pascals Law, Continuity equation and Bernoulli's theorem<br>TLO 1.3 Use suitable grade of hydraulic oil for given application<br>TLO 1.4 Classify fluid operated systems | **Unit - I Fundamental of fluid power**<br>1.1 Fluid Properties: Density, Viscosity, Specific gravity, Lubricity, Demusibility, Neutralization number, Low foam tendency<br>1.2 Pascals Law, Continuity equation, Bernoulli's theorem (No numerical)<br>1.3 ISO grades of hydraulic oil<br>1.4 Types of fluid operated systems - Oil hydraulic and Pneumatic system, Advantages and limitations and applications and comparison. | Fluid samples for Demonstration<br>Display charts |
| 2 | TLO 2.1 Classify hydraulic pump/ Air compressor<br>TLO 2.2 Select the Pump /Compressor relevant for given application.<br>TLO 2.3 State function of Hydraulics/Pneumatics accessories. | **Unit - II Pumps, Compressor, Accessories in Hydraulics/ Pneumatics**<br>2.1 Classification of Hydraulic Pumps, Construction and working of Gear pump, Vane pump, Lobe pump and axial piston pump. Selection criterion for pump<br>2.2 Classification of Compressors, Construction and working of Reciprocating compressor (Single/Multistage), Vane, Screw compressor, Selection criterion for compressor<br>2.3 Accessories in Hydraulics/Pneumatics: Oil and Air filter, Accumulator, Pressure intensifier, FRL unit, Muffler, pressure gauges, oil reservoir and air receiver | Models/Display charts<br>Animation videos<br>PPT |

**FLUID POWER AND INDUSTRIAL AUTOMATION** **Course Code : 314339**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 3 | TLO 3.1 Classify control valves<br>TLO 3.2 Describe construction and working of Control valves in Hydraulics/ Pneumatics<br>TLO 3.3 Explain construction and working of actuators in Hydraulics/Pneumatics | **Unit - III Control valves and Actuators in Hydraulics/ Pneumatics**<br>3.1 Control valves: Classification of control valves, Hydraulic system control valves- Construction and working of - Pressure control valve, Pressure relief valve, Pressure reducing Valve, Sequence Valve, Flow control valve - Fixed and Variable type, Direction control valve- 2/2, 3/2,4/2,4/3,5/2 DCV , Actuating methods- Lever operated, Push button, Solenoid operated.<br>3.2 Pneumatic system control valves - Construction and working of Pilot control valve, Shuttle valve, Twin pressure Valve, Time delay valve.<br>3.3 Hydraulic/Pneumatics Actuators: Construction and working of linear actuator (Single, Double acting cylinder) and rotary actuator (Gear motor, Vane motor, Turbine air motor) | Models/ Display charts<br>Animation videos<br>PPT |
| 4 | TLO 4.1 Draw symbols of various components used in hydraulic and pneumatics<br>TLO 4.2 Construct oil hydraulic circuit for given application<br>TLO 4.3 Construct Pneumatic circuit for given application<br>TLO 4.4 List safety precautions in Hydraulic/pneumatics systems | **Unit - IV Oil Hydraulic and Pneumatic circuits**<br>4.1 ISO symbols for Oil hydraulics and Pneumatics system components<br>4.2 Oil Hydraulic circuits: General layout of Oil Hydraulic system - Actuation of Single acting, Double acting cylinder, Actuation of Unidirectional and Bi-directional Hydro-motor, Speed control (Meter-in, Meter out), Sequencing circuits for simple operations<br>4.3 Pneumatic circuits: General layout of Pneumatic system , Actuation of Single acting, Double acting cylinder, Actuation of Unidirectional and Bi-directional Air -motor, Speed control of Double acting cylinder and bi directional motor, Sequencing circuits for simple operations<br>4.4 Hazards and safety in hydraulic/pneumatics systems | Display chart for ISO symbols<br>Demonstration of trainer/set up<br>Display Charts of fluid power circuits<br>Animation of fluid power circuits |
| 5 | TLO 5.1 List function of automation devices<br>TLO 5.2 Explain simple automation circuit using solenoid operated DC valve with diagram.<br>TLO 5.3 Draw impulse or pilot control automation circuits<br>TLO 5.4 Explain automation circuits using special control valves with diagram.<br>TLO 5.5 Describe simple electropneumatic circuits with diagram. | **Unit - V Oil Hydraulic and Pneumatic circuits for automation**<br>5.1 Devices for automation: Push button switches, Limit switches, Proximity sensors, Solenoid, relays, Timers,<br>5.2 Automation circuit of SAC (Single Acting Cylinder) and DAC (Double Acting Cylinder) using solenoid operated DCV<br>5.3 Automation circuit of SAC and DAC using Single / double pilot operated DCV (impulse operation)<br>5.4 Automation circuits using logic gates valves (Shuttle valve - OR gate, Twin pressure valve- AND Gate), Time delay valve<br>5.5 Basic electropneumatic circuits for SAC and DAC | Display Charts of Automation circuits.<br>Demonstration of trainer/set up<br>Animation of fluid power circuits |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

**FLUID POWER AND INDUSTRIAL AUTOMATION** **Course Code : 314339**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 1.1 Measure parameters of Total energy (Potential, Kinetic and Pressure energy)<br>LLO 1.2 Calculate parameters of Total energy (Potential, Kinetic and Pressure energy) | 1 | *Verification of Bernoulli's theorem | 2 | CO1 |
| LLO 2.1 Identify components of hydraulic and pneumatic system | 2 | Hydraulic and pneumatic system components. | 2 | CO1 |
| LLO 3.1 Interpret specifications of pump and compressor mounted on trainer kit.<br>LLO 3.2 Operate pump and compressor to measure pressure and flow rate. | 3 | *Functional parameters of Oil hydraulic pump and compressor. | 2 | CO2 |
| LLO 4.1 Identify components of control valves<br>LLO 4.2 Set/Operate Control valves for given application | 4 | *Pressure relief valve, direction control valve and flow control valve. | 2 | CO3 |
| LLO 5.1 Identify functional components of actuators.<br>LLO 5.2 Operate and measure speed of actuators | 5 | *SA, DA cylinders and motors in fluid power system. | 2 | CO3 |
| LLO 6.1 Identify components of Shuttle valve, Twin pressure valve.<br>LLO 6.2 Set/Operate Shuttle valve, Twin pressure valve. | 6 | Shuttle valve, Twin pressure valve used in pneumatic system. | 2 | CO3 |
| LLO 7.1 Select components for given speed control circuit<br>LLO 7.2 Construct hydraulic circuit<br>LLO 7.3 Test speed variation of an actuators | 7 | Hydraulic circuit for SAC and DAC, Hydro-motor. | 2 | CO4 |
| LLO 8.1 Select components for given speed control circuit.<br>LLO 8.2 Construct and actuate hydraulic speed control circuit. | 8 | *Speed control circuits: Meter-in and Meter out hydraulic circuit. | 2 | CO4 |
| LLO 9.1 Select components for given circuit.<br>LLO 9.2 Construct pneumatic circuit.<br>LLO 9.3 Operate given actuators | 9 | *Pneumatic circuits for SAC and DAC, Air motor. | 2 | CO4 |
| LLO 10.1 Select components for given speed control circuit<br>LLO 10.2 Construct and actuate pneumatic speed control circuit | 10 | Speed control circuits for pneumatic system | 2 | CO3<br>CO4 |
| LLO 11.1 Select components for given sequencing hydraulic circuit.<br>LLO 11.2 Connect and test given sequencing hydraulic circuit. | 11 | Sequencing hydraulic circuit. | 2 | CO3<br>CO4 |

**FLUID POWER AND INDUSTRIAL AUTOMATION** **Course Code : 314339**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 12.1 Select components for given sequencing pneumatic circuit.<br>LLO 12.2 Connect given sequencing pneumatic circuit<br>LLO 12.3 Test the sequencing circuit. | 12 | *Sequencing pneumatic circuit. | 2 | CO3<br>CO4 |
| LLO 13.1 Select components for given Automation circuit.<br>LLO 13.2 Construct and actuate given automation circuit. | 13 | Automation circuit for SAC and DAC using solenoid operated DCV | 2 | CO3<br>CO5 |
| LLO 14.1 Select components for given impulse automation circuit<br>LLO 14.2 Connect and test given impulse automation circuit. | 14 | Impulse automation circuit for SAC and DAC using Single / double pilot operated DCV(use trainer or Fluid SIM free software) | 2 | CO3<br>CO5 |
| LLO 15.1 Select components for given automation circuit.<br>LLO 15.2 Connect and test given automation circuit. | 15 | *Automation circuits using logic gates valves (OR/AND gate) (use trainer or Fluid SIM free software) | 2 | CO3<br>CO5 |
| LLO 16.1 Select components for given circuit.<br>LLO 16.2 Connect pneumatic circuit.<br>LLO 16.3 Test given circuit. | 16 | Electro-pneumatic circuits for SAC and DAC | 2 | CO3<br>CO5 |

**Note : Out of above suggestive LLOs -**

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**Assignment**

- Collect information of applications of hydraulic system in universal testing machine with the help of Laboratory visit - study of type of pump used, oil pressure, type of actuator used, auto cut off mechanism after specimen test.
- Prepare report of Market Survey of various grades of hydraulic oil. - manufacturer, specify viscosity, working temperature range, cost/liter, packaging type and capacity
- Prepare display chart for different hydraulic and pneumatic equipment used at service station (Type of equipment, Function and photograph of actual use)
- Prepare PPT on application of Hydraulic equipment used at construction site. Student may visit nearby site to collect information related to type, function, images of actual operations,etc
- Prepare a display chart of different ISO symbols of hydraulic/pneumatic components. (Use colour sketch pens and drawing sheet)

**Micro project**

- Prepare report on different actuators for mechatronic applications as per following parameters. - stroke length, bore, diameter of cylinder, working pressure, Bursting pressure, torque, speed, types of mountings using internet

- Prepare report on specification of hydraulic pumps using internet by visiting website of suppliers. Prepare a table with following specification: make/ manufacturer, Pressure range, Type of pump, type of prime mover required, compatibility with different grades of oil.
- Prepare working models of any hydraulic system using disposable syringe. e.g. Robot arm movement
- Prepare a display chart on different types of actuators used for earthmoving equipment like tractor trolley, JCB, Crane (Type of Actuator , Function and photograph of actual use)
- Prepare a model of any type of pump size 60 cm X 60 cm using card board. Use various colours to show casing ports and constructional elements.

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | Bernoulli's theorem apparatus With Pipe of varying cross sectional area, Pump of Max Head 21 Meter, Water flow 1.35 Lit/Sec, Motor rating -O.37KW, Sump Tank Capacity:250 Liter | 1 |
| 2 | Festo Fluid SIM free software/ any other suitable software | 14,15 |
| 3 | Limit switches (Operating pressure range : 3 to 70 kgf/cm², Operating speed range : 8 -100mm/sec, Operating temperature range : -10 to 80 Deg.Celsius), Solenoid operated valves (12/24VDC), proximity switches (range of 0 - 40 mm), roller operated valves (maximum working pressure 210 bar, Flowrate 60 l/min) | 15,16 |
| 4 | Charts, cut section models, actual samples of different components of fluid power system | 2,3,4 |
| 5 | Hydraulic Trainer kit with various components like Hydraulic power pack, Set of Pressure relief, Pressure reducing and Sequence valve , 3/2 , 4/2,4/3 DCV, Flow control valve with built in check valve, pipes and hoses, SA Cylinder, DA Cylinder | 2,3,4,7,8,11,13 |
| 6 | Pneumatic trainer kit with portable compressor pressure up to 12 Bar, FRL Unit, 3/2, 5/2,5/3 DCV, Solenoid operated valves, Flow control valve with check valve, Twin pressure valve, Shuttle valve, pipes and low pressure hoses, SA Cylinder, DA Cylinder | 5,6,9,10,12,14,15 |

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | I | Fundamental of fluid power | CO1 | 5 | 2 | 4 | 2 | 8 |
| 2 | II | Pumps, Compressor, Accessories in Hydraulics/ Pneumatics | CO2 | 10 | 2 | 8 | 4 | 14 |

**FLUID POWER AND INDUSTRIAL AUTOMATION** **Course Code : 314339**

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 3 | III | Control valves and Actuators in Hydraulics/ Pneumatics | CO3 | 10 | 4 | 4 | 8 | 16 |
| 4 | IV | Oil Hydraulic and Pneumatic circuits | CO4 | 10 | 4 | 4 | 8 | 16 |
| 5 | V | Oil Hydraulic and Pneumatic circuits for automation | CO5 | 10 | 2 | 4 | 10 | 16 |
| **Grand Total** | | | | **45** | **14** | **24** | **32** | **70** |

## X. ASSESSMENT METHODOLOGIES/TOOLS

**Formative assessment (Assessment for Learning)**

- Two-unit tests of 30 marks and average of two-unit tests. · For laboratory learning term work -25 Marks · For Self Learning 25 Marks

**Summative Assessment (Assessment of Learning)**

- End semester assessment of 70 marks.

## XI. SUGGESTED COS - POS MATRIX FORM

| 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 | PSO-3 |
| CO1 | 3 | - | - | 2 | 2 | 2 | 3 | | | |
| CO2 | 3 | - | - | 2 | - | 2 | 2 | | | |
| CO3 | 3 | - | - | 2 | - | 2 | 2 | | | |
| CO4 | 3 | - | 2 | 2 | 3 | 2 | 3 | | | |
| CO5 | 3 | - | 2 | 3 | 3 | 2 | 3 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | Dr. P. N. Modi, Dr. S. M. Seth | Hydraulics and Fluid mechanics including hydraulics machines | Standard Book House, Rajsons Publication Pvt. Ltd., New Delhi, ISBN 978-81-89401-26-9, Year: 2017 |
| 2 | C. P. Kothandaraman, R. Rudramoorthy | Fluid Mechanics and Machinery | New Age International (P) Limited, New Delhi, ISBN : 978-81-224-3398-2, Year : 2012 |

**FLUID POWER AND INDUSTRIAL AUTOMATION** **Course Code : 314339**

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 3 | Majumdar S.R. | Oil Hydraulic system-Principles and maintenance | Tata McGraw Hill, ISBN: 978-0-07-463748-7, Year : 2013 |
| 4 | Majumdar S.R. | Pneumatics Systems Principles and Maintenance | Tata McGraw Hill, ISBN: 978-0-07-463748-7, Year : 2013 |
| 5 | Shanmuga Sundaram | Hydraulic and Pneumatic Controls | S. Chand Publishing, New Delhi, ISBN: 978-8-12-192635-5, Year:2013 |
| 6 | Andrew Parr | Hydraulics & Pneumatics A Technicians & Engineers Guide | Butterworth-Heinemann Publisher, New Delhi ISBN: 978-0-08-096675-5, Year: 2006 |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | https://en.wikipedia.org/wiki/Hydraulic_pump | Hydraulic Pumps (all types) |
| 2 | https://www.youtube.com/watch?v=Qy1iV6EzNHg | Animation of Hydraulic pumps (all types) |
| 3 | https://www.youtube.com/watch?v=pWuxYnqYDnk | Animation of Hydraulic pumps |
| 4 | https://www.youtube.com/watch?v=sEVTIRYHoGg | Eaton Pump assembly |
| 5 | https://www.youtube.com/watch?v=XAItnsUcES0 | Pneumatic control valves animation |
| 6 | https://www.youtube.com/watch?v=yIot4shcOkE | Control valve symbol generation |
| 7 | https://www.youtube.com/watch?v=jsMJbJQkGTs | Animation of D.C.Valve |
| 8 | https://www.youtube.com/watch?v=CQPwvWXbV3w | Animation of 4/2,4/3 D.C Valves |
| 9 | https://www.youtube.com/watch?v=bovfDsAYSbc | Animation of Hydraulic cylinder |
| 10 | https://www.youtube.com/watch?v=icaqvfAtccY | Telescopic cylinder animation |
| 11 | https://www.youtube.com/watch?v=MmYpzgh6Gok | Pneumatic cylinder |
| 12 | https://www.youtube.com/watch?v=WRCj5Tnopo0 | Pilot control pneumatic circuits |
| 13 | https://www.youtube.com/watch?v=4eCuPVxezzY | Speed control hydraulic circuit |
| 14 | https://www.youtube.com/watch?v=2HNkIldunyY | Material Handling Automated System |
| 15 | https://www.youtube.com/watch?v=355XnDsAkDw | Pneumatic components automation line |
| 16 | https://www.youtube.com/watch?v=PvYu200BVy4 | Introduction to Festo FluidSIM 6 |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

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**ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS** **Course Code : 314014**

| | |
|---|---|
| **Programme Name/s** | **: Architecture Assistantship/ Automobile Engineering./ Agricultural Engineering/ Architecture/ Fashion & Clothing Technology/ Dress Designing & Garment Manufacturing/ Food Technology/ Instrumentation & Control/ Instrumentation/ Interior Design & Decoration/ Interior Design/ Mechanical Engineering/ Mechatronics/ Medical Laboratory Technology/ Medical Electronics/ Production Engineering/ Printing Technology/ Surface Coating Technology/ Textile Technology/ Travel and Tourism/ Textile Manufactures** |
| **Programme Code** | **: AA/ AE/ AL/ AT/ DC/ DD/ FC/ IC/ IS/ IX/ IZ/ ME/ MK/ ML/ MU/ PG/ PN/ SC/ TC/ TR/ TX** |
| **Semester** | **: Fourth / Fifth / Sixth** |
| **Course Title** | **: ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS** |
| **Course Code** | **: 314014** |

## I. RATIONALE

Entrepreneurship and Startup is introduced in this curriculum to develop the entrepreneurship traits among the students before they enter into the professional life. By exposing and interacting with entrepreneurship and startup eco-system, student will develop the entrepreneurial mind set. The innovative thinking with risk taking ability along with other traits are to be inculcated in the students through micro projects and training. This exposure will be instrumental in orienting the students in transforming them to be job generators after completion of Diploma in Engineering.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

• Develop project proposals for launching small scale enterprises and starts up.

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify one's entrepreneurial traits.
- CO2 - Use information collected from stakeholder for establishing/setting up/founding starts up
- CO3 - Use support systems available for Starts up
- CO4 - Prepare project plans to manage the enterprise effectively

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | Total Marks |
| | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 314014 | ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS | EDS | AEC | 1 | - | 2 | 1 | 4 | 2 | - | - | - | - | - | 50 | 20 | 25@ | 10 | 25 | 10 | 100 |

**ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS** **Course Code : 314014**

**Total IKS Hrs for Sem. :** 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 Compare advantages and disadvantages of Entrepreneurship<br>TLO 1.2 Identify entrepreneurial traits through self-analysis<br>TLO 1.3 Compare risk associated with different type of enterprise | **Unit - I Introduction to Entrepreneurship Development**<br>1.1 Entrepreneurship as a career – charms, advantages, disadvantages , scope- local and global<br>1.2 Traits of successful entrepreneur: consistency, creativity, initiative, independent decision making, assertiveness, persuasion, persistence, information seeking, handling business communication, commitment to work contract, calculated risk taking, learning from failure<br>1.3 Types of enterprises and their features : manufacturing, service and trading | Presentations<br>Lecture Using Chalk-Board |
| 2 | TLO 2.1 Explain Important factors essential for selection of product/service and selection of process<br>TLO 2.2 Suggest suitable place for setting up the specified enterprise on the basis of given data/circumstances with justification.<br>TLO 2.3 Suggest steps for the selection process of an enterprise for the specified product or service with justification.<br>TLO 2.4 Plan a market study /survey for the specified enterprise | **Unit - II Startup Selection Process**<br>2.1 Product/Service selection: Process, core competence, product/service life cycle, new product/ service development process, mortality curve, creativity and innovation in product/ service modification / development<br>2.2 Process selection: Technology life cycle, forms and cost of transformation, factors affecting process selection, location for an industry, material handling.<br>2.3 Market study procedures: questionnaire design, sampling, market survey, data analysis<br>2.4 Getting information from concerned stakeholders such as Maharashtra Centre for Entrepreneurship Development[MCED], National Institute for Micro, Small and Medium Enterprises [NI-MSME], Prime Minister Employment Generation Program [PMEGP], Directorate of Industries[DI], Khadi Village Instries Commission[KVIC] | Presentations<br>Lecture Using Chalk-Board |

**ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS** **Course Code : 314014**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 3 | TLO 3.1 Explain categorization of MSME on the basis of turnover and investment<br>TLO 3.2 Describe support system provided by central and state government agencies<br>TLO 3.3 State various schemes of government agencies for promotion of entrepreneurship<br>TLO 3.4 Describe help provided by the non-governmental agencies for the specified product/service<br>TLO 3.5 Compute breakeven point, ROI and ROS for the specified business enterprise, stating the assumptions made | **Unit - III Support System for Startup**<br>3.1 Categorization of MSME, ancillary industries<br>3.2 Support systems- government agencies: MCED, NI-MSME, PMEGP,DI, KVIC<br>3.3 Support agencies for entrepreneurship guidance, training, registration, technical consultation, technology transfer and quality control, marketing and finance.<br>3.4 Breakeven point, return on investment (ROI) and return on sales (ROS). | Presentations<br>Lecture Using Chalk-Board |
| 4 | TLO 4.1 Explain key elements for the given business plan with respect to their purpose/size<br>TLO 4.2 Justify USP of the given product/ service from marketing point of view.<br>TLO 4.3 Formulate business policy for the given product/service.<br>TLO 4.4 Choose relevant negotiation techniques for the given product/ service with justification<br>TLO 4.5 Identify risks that you may encounter for the given type of business/enterprise with justification.<br>TLO 4.6 Describe role of the incubation centre and accelerators for the given product/service. | **Unit - IV Managing Enterprise**<br>4.1 Techno commercial Feasibility study, feasibility report preparation and evaluation criteria<br>4.2 Ownership, Capital, Budgeting, Matching entrepreneur with the project<br>4.3 Unique Selling Proposition [U.S.P.]: Identification, developing a marketing plan.<br>4.4 Preparing strategies of handling business: policy making, negotiation and bargaining techniques<br>4.5 Risk Management: Planning for calculated risk taking, initiation with low cost projects, integrated futuristic planning, definition of startup cycle, ecosystem , angel investors, venture capitalist<br>4.6 Incubation centers and accelerators : Role and procedure | Presentations<br>Lecture Using Chalk-Board |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 1.1 Collect information of successful entrepreneurial traits | 1 | *Preparation of report on entrepreneurship as a career | 2 | CO1 |
| LLO 2.1 Identify different traits as an entrepreneur from various field<br>LLO 2.2 Suggest different traits from identified problem | 2 | Case study on ‘Traits of Entrepreneur’ | 2 | CO1 |

**ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS** **Course Code : 314014**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 3.1 Explore probable risks for identified enterprise. | 3 | *Case study on 'Risks associated with enterprise | 2 | CO1 |
| LLO 4.1 Identify new product for development<br>LLO 4.2 Prepare a newly developed product | 4 | *Preparation of report on 'Development of new Product' | 2 | CO1<br>CO2 |
| LLO 5.1 Identify Process for development of product for new startup | 5 | Preparation of Report on ' Process selection ' for new startup | 2 | CO1<br>CO2<br>CO3 |
| LLO 6.1 Develop questioner for market survey | 6 | *Market survey for setting up new Start up | 2 | CO2<br>CO3 |
| LLO 7.1 Interpret the use of Technology Life Cycle | 7 | A Case study on ' Technology life cycle' of any successful entrepreneur. | 2 | CO3 |
| LLO 8.1 Use information related to support of startups from Government and non-government agencies'<br>LLO 8.2 Prepare report for setting up startup | 8 | *Preparation of report on 'Information for setting up new startup' from MCED/MSME/KVIC etc | 2 | CO3<br>CO4 |
| LLO 9.1 Compute ROI of successful enterprise. | 9 | Case study on 'Return on Investment (ROI)'of any successful startup | 2 | CO3 |
| LLO 10.1 Calculate of ROS of any successful enterprise | 10 | Case study on 'Return on sales (ROS)'of any successful startup | 2 | CO3 |
| LLO 11.1 Calculate Brake even point of any enterprise | 11 | Preparation of report on 'Brake even point calculation' of any enterprise. | 2 | CO3<br>CO4 |
| LLO 12.1 Prepare feasibility report of given business | 12 | *Preparation of report on 'feasibility of any Techno-commercial business" | 2 | CO4 |
| LLO 13.1 Plan a USP of any enterprise. | 13 | *A case study based on 'Unique selling Proposition (USP) of any successful enterprise | 2 | CO4 |
| LLO 14.1 Prepare a project report using facilities of Atal Incubation center. | 14 | *Prepare project report for starting new startup using 'Atal incubation center (AIC) | 2 | CO1<br>CO2<br>CO3<br>CO4 |

**Note : Out of above suggestive LLOs -**

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**Micro project**

- Prepare a ' Women entrepreneurship business plan ' Choose relevant government scheme for the product/service
- Prepare a 'Pitch- desk' for your start up
- Prepare a business plan for a. Market research b. Advertisement agency c. Placement Agency d. Repair and Maintenance agency e. Tour and Travel agency
- Prepare a 'Social entrepreneurship business plan, plan for CSR funding.

**ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS** **Course Code : 314014**

- Prepare a business plan for identified projects by using entrepreneurial eco system for the same (Schemes, incentives, incubators etc.)

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | Computers with internet and printer facility | All |

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

| Sr.No | Unit | Unit Title | Aligned COs | Learning Hours | R-Level | U-Level | A-Level | Total Marks |
|---|---|---|---|---|---|---|---|---|
| 1 | I | Introduction to Entrepreneurship Development | CO1 | 5 | 0 | 0 | 0 | 0 |
| 2 | II | Startup Selection Process | CO2 | 4 | 0 | 0 | 0 | 0 |
| 3 | III | Support System for Startup | CO3 | 3 | 0 | 0 | 0 | 0 |
| 4 | IV | Managing Enterprise | CO4 | 3 | 0 | 0 | 0 | 0 |
| **Grand Total** | | | | **15** | **0** | **0** | **0** | **0** |

## X. ASSESSMENT METHODOLOGIES/TOOLS

**Formative assessment (Assessment for Learning)**

**Summative Assessment (Assessment of Learning)**

- End of Term Examination - Viva-voce

## XI. SUGGESTED COS - POS MATRIX FORM

**ENTREPRENEURSHIP DEVELOPMENT AND STARTUPS** **Course Code : 314014**

| 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 | PSO-3 |
| CO1 | 2 | 2 | 2 | - | - | 3 | 2 | | | |
| CO2 | 2 | 2 | 2 | 2 | - | 3 | 2 | | | |
| CO3 | 2 | 2 | 2 | 2 | - | 3 | 2 | | | |
| CO4 | 2 | 2 | 2 | 2 | - | 3 | 2 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | Dr. Nishith Dubey, Aditya Vyas , Annu Soman , Anupam Singh | Un- boxing Entrepreneurship your self help guide to setup a successful business | Indira Publishing House ISBN-2023,978-93-93577-70-2 |
| 2 | Gujral, Raman | Reading Material of Entrepreneurship Awareness Camp | Entrepreneurship Development Institute of India (EDI), GOI, 2016 Ahmedabad |
| 3 | Chitale, A K | Product Design and Manufacturing | PHI Learning, New Delhi, 2014; ISBN: 9788120348738 |
| 4 | Charantimath, Poornima | Entrepreneurship Development Small Business Entrepreneurship | Pearson Education India, New Delhi; ISBN: 9788131762264 |
| 5 | Khanka, S.S. | Entrepreneurship and Small Business Management | S.Chand and Sons, New Delhi, ISBN: 978-93-5161-094-6 |

## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | http://www.mced.nic.in/allproduct.aspx | MCED Product and Plan Details |
| 2 | http://niesbud.nic.in/Publication.html | The National Institute for Entrepreneurship and Small Business Development Publications |
| 3 | http://niesbud.nic.in/docs/1standardized.pdf | Courses : The National Institute for Entrepreneurship and Small Business Development |
| 4 | https://www.nabard.org/content1.aspx?id=23andcatid=23andmid=530 | Government Schemes |
| 5 | https://www.nabard.org/Tenders.aspx?cid=501andid=24 | NABARD - Information Centre |
| 6 | http://www.startupindia.gov.in/pdffile.php?title=Startup%20India%20Action%20Planandtype=Actionandq=Action%20Plan.pdfandcontent_type=Actionandsubmenupoint=action | Start Up India |
| 7 | http://www.ediindia.org/institute.html | About - Entrepreneurship Development Institute of India (EDII) |

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| Sr.No | Link / Portal | Description |
|---|---|---|
| 8 | http://www.nstedb.com/training/training.htm | NSTEDB - Training |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**MSBTE Approval Dt. 21/11/2024** **Semester - 4 / 5 / 6, K Scheme**

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**COMPUTER AIDED MECHATRONICS DRAFTING** **Course Code : 314015**

**Programme Name/s** : **Mechatronics**
**Programme Code** : **MK**
**Semester** : **Fourth**
**Course Title** : **COMPUTER AIDED MECHATRONICS DRAFTING**
**Course Code** : **314015**

## I. RATIONALE

The process of drawing and drafting has evolved with the advancement of technology from a manual process into a digital technique. The skills of Computer Aided Drawing and Drafting (CADD) have become an essential element of this evolution process. This course provides the designers with the powerful tools to modernize the creation, modification and visualization of mechatronics drawings.

## II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Apply the knowledge and skills of CADD software to create and read electromechanical drawings efficiently and accurately as per industry standards.

## III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Use basic commands in CADD software.
- CO2 - Draw complex 2D drawings in CADD software using draw and modify tools.
- CO3 - Use CADD software to give dimensions and write text on 2D geometric entities.
- CO4 - Plot given 2D entities using proper plotting parameters in CADD software.
- CO5 - Draw electromechanical circuits in CADD software.

## IV. TEACHING-LEARNING & ASSESSMENT SCHEME

| Course Code | Course Title | Abbr | Course Category/s | Learning Scheme | | | | | Credits | Assessment Scheme | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Actual Contact Hrs./Week | | | SLH | NLH | | Paper Duration | Theory | | | | Based on LL & TL | | | | Based on SL | | Total Marks |
| | | | | | | | | | | | | | | | Practical | | | | | | |
| | | | | CL | TL | LL | | | | | FA-TH | SA-TH | Total | | FA-PR | | SA-PR | | SLA | | |
| | | | | | | | | | | | Max | Max | Max | Min | Max | Min | Max | Min | Max | Min | |
| 314015 | COMPUTER AIDED MECHATRONICS DRAFTING | CAM | SEC | - | - | 4 | 2 | 6 | 3 | - | - | - | - | - | 25 | 10 | 25# | 10 | 25 | 10 | 75 |

**COMPUTER AIDED MECHATRONICS DRAFTING** **Course Code : 314015**

**Total IKS Hrs for Sem. :** 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

## V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 1 | TLO 1.1 Describe the importance of computer in drafting and designing.<br>TLO 1.2 Set the CADD workspace and interface for the given situation<br>TLO 1.3 Prepare drawing using User Coordinate System (UCS) and World Coordinate System (WCS)<br>TLO 1.4 Apply different object selection methods in a given situation.<br>TLO 1.5 Use various commands in application menu bar. | **Unit - I Fundamentals of CAD Drawing**<br>1.1 Fundamentals of Computer Aided Drafting and its applications, Various Software for Computer Aided Drafting.<br>1.2 CADD Interface: Application Menu, Quick Access Toolbar, Ribbons, Info Center, Command Window, Graphical Area, Status Bar<br>1.3 CADD initial setting commands: Snap, grid, Ortho, Osnap, Dynamic input, Limits, Units, Ltscale, Object tracking.<br>1.4 Co-ordinate System- Cartesian and Polar, Absolute and Relative mode, Direct Distance Entry, UCS, WCS.<br>1.5 Object Selection methods- picking, window, crossing, fence, last and previous.<br>1.6 Opening, saving and closing a new and existing drawing. | Video<br>Demonstrations<br>Presentations<br>Hands-on |
| 2 | TLO 2.1 Draw simple 2D entities using given draw commands.<br>TLO 2.2 Apply formatting commands<br>TLO 2.3 Determine coordinates, distance, area, length, centroid of the given 2D entity<br>TLO 2.4 Use viewing commands. | **Unit - II Draw, Formatting, Enquiry and Zoom Commands**<br>2.1 Draw Command - Line, Polyline, arc, circle, rectangle, polygon, ellipse, spline, block, hatch.<br>2.2 Formatting commands - Layers, block, linetype, lineweight, color.<br>2.3 Enquiry commands – distance, area.<br>2.4 Zoom Commands – all, previous, out, in, extent, Realtime, dynamic, window, pan. | Video<br>Demonstrations<br>Presentations<br>Hands-on |

**COMPUTER AIDED MECHATRONICS DRAFTING** **Course Code : 314015**

| Sr.No | Theory Learning Outcomes (TLO's)aligned to CO's. | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's. | Suggested Learning Pedagogies. |
|---|---|---|---|
| 3 | TLO 3.1 Draw given complex 2D entities using relevant modify commands.<br>TLO 3.2 Use grip command to manipulate given 2D entity. | **Unit - III Modify and Edit Commands**<br>3.1 Modify Command - Erase, trim, extend, copy, move, mirror, offset, fillet, chamfer, array, rotate, scale, lengthen, stretch, measure, break, divide, explode, align.<br>3.2 Editing Objects by Using Grips - Moving, Rotating, Scaling, Mirroring and Stretching. | Video<br>Demonstrations<br>Presentations<br>Hands-on |
| 4 | TLO 4.1 Use various styles of dimensioning to drawn 2D entities.<br>TLO 4.2 Apply Geometric and dimension tolerance symbols on the given entity.<br>TLO 4.3 Write text on given 2D entity.<br>TLO 4.4 Prepare table in drawing.<br>TLO 4.5 Prepare new template for drawing as per requirement.<br>TLO 4.6 Plot 2D entities using proper plotting parameters. | **Unit - IV Dimensioning, Text and Plot Commands**<br>4.1 Dimensioning commands - Dimension styles, Dimensional Tolerances and Geometrical Tolerances, Modify dimension style.<br>4.2 Text commands - dtext, mtext command.<br>4.3 Insert table – table, tablestyle command.<br>4.4 Template Drawing- Standard template, loading template, create new template.<br>4.5 Plotting a drawing – adding plotter/printer, page setup, plot style commands. | Video<br>Demonstrations<br>Presentations<br>Hands-on |
| 5 | TLO 5.1 Prepare the drawing by circuit builder for given situation.<br>TLO 5.2 Apply Modify Commands<br>TLO 5.3 Insert components in the circuits.<br>TLO 5.4 Apply Edit commands to the circuits | **Unit - V Schematic Components and Editing**<br>5.1 Circuit builder, insert pneumatic hydraulic and PID components command.<br>5.2 Edit, copy, Move, Delete, Scoot, Toggle, NO/NC, Reverse connector, Retag and Swap command.<br>5.3 Insert-Wire, Multiple bus, 3-phase, Source arrow, Ladder.<br>5.4 Edit-Wire number, Wire trim, Add rung, Strech wire, Toggle wire, Flip wire gap. | Video<br>Demonstrations<br>Presentations<br>Hands-on |

## VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 1.1 Use basic commands in CADD for given situation. | 1 | Basic settings of CADD software | 4 | CO1 |
| LLO 2.1 Use of draw commands in CADD for given drawing .<br>LLO 2.2 Draw given 2D entities in CADD using Draw commands individually. | 2 | *Drawing 2-D entities like Line, Polyline, Circle, Rectangle, Polygon and Ellipse by using CADD software. | 4 | CO1<br>CO2 |
| LLO 3.1 Use formatting commands in CADD for given drawing.<br>LLO 3.2 Draw given 2D geometries in CADD using Draw, Edit and Modify commands. | 3 | Drawing simple 2-D objects using any combination of 2 or more commands, like polygon+circle, line+circle, etc. | 4 | CO1<br>CO2 |

**COMPUTER AIDED MECHATRONICS DRAFTING** **Course Code : 314015**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 4.1 Use draw commands in CADD for given objects .<br>LLO 4.2 Draw 2D entities in CADD using Draw, Edit and Modify commands.<br>LLO 4.3 Apply dimension and write text on 2D geometric entities for given drawing. | 4 | *Drawing complex 2-D objects like pulley, gear, hexagonal bolts, rivets etc. | 4 | CO1<br>CO2<br>CO3 |
| LLO 5.1 Use basic setting commands in CADD for given situation.<br>LLO 5.2 Draw given 2D entities in CADD.<br>LLO 5.3 Apply dimension and write text on 2D geometric entities. | 5 | Drawing complex 2-D object like coupling, joints, valves, clamps etc. | 4 | CO1<br>CO2<br>CO3 |
| LLO 6.1 Use basic construction commands in CADD for given object.<br>LLO 6.2 Draw given 2D entities in CADD using first angle of projection .<br>LLO 6.3 Apply dimension and write text on 2D geometric entities. | 6 | Drawing one problems of orthographic projections using first angle method of projection. | 4 | CO1<br>CO2<br>CO3 |
| LLO 7.1 Use advance construction commands in CADD for given object.<br>LLO 7.2 Draw 2D objects on sectional orthographic in CADD for given situation<br>LLO 7.3 Apply dimension and write text on 2D geometric entities. | 7 | *Drawing one problem of sectional orthographic projections using First angle method of projection. | 4 | CO1<br>CO2<br>CO3 |
| LLO 8.1 Use advance drawing commands in CADD for given drawing .<br>LLO 8.2 Draw 2D assembly in CADD for given objects.<br>LLO 8.3 Apply dimension and write text on given 2D geometric entities. | 8 | *Drawing an assembly drawing from the given detailed drawing showing assembly dimensions, part number and bill of Material. | 4 | CO1<br>CO2<br>CO3 |
| LLO 9.1 Draw detailed 2D entities from given assembly in CADD.<br>LLO 9.2 Apply dimension and write text on same 2D geometric entities. | 9 | Drawing working drawings from given assembly drawing showing conventional representation, dimensions, geometrical tolerances and machining symbols. | 4 | CO1<br>CO2<br>CO3 |
| LLO 10.1 Draw 2D conventional representation for given parts.<br>LLO 10.2 Apply dimension and write text on given 2D geometric entities. | 10 | Show conventional representation, dimensional, geometrical tolerances, surface finish symbols and bill of material in assembly drawing | 4 | CO1<br>CO2<br>CO3 |

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| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| LLO 11.1 Use basic commands in ECAD or Circuitmaker software.<br>LLO 11.2 Draw electromechanical circuits using ECAD or Circuitmaker software. | 11 | *Drawing simple circuit diagram using circuit building commands. | 4 | CO1<br>CO2<br>CO3<br>CO5 |
| LLO 12.1 Insert basic symbols in ECAD or Circuitmaker for given circuits.<br>LLO 12.2 Draw electromechanical circuits using ECAD or Circuitmaker software. | 12 | Drawing and modifying simple circuit like SMPS use in computer / amplifier using Edit components command. | 4 | CO1<br>CO2<br>CO3<br>CO5 |
| LLO 13.1 Insert electropneumatic symbols in ECAD or Circuitmaker for given circuits.<br>LLO 13.2 Draw given electromechanical circuits using ECAD or Circuitmaker | 13 | *Drawing simple Electro-pneumatic circuit using insert pneumatic and PID components command. | 4 | CO1<br>CO2<br>CO3<br>CO5 |
| LLO 14.1 Insert Electro-hydraulic symbols in ECAD or Circuitmaker for given circuits.<br>LLO 14.2 Draw given electromechanical circuits using ECAD or Circuitmaker. | 14 | *Drawing simple Electro-hydraulic circuit using insert pneumatic and PID components command. | 4 | CO1<br>CO2<br>CO3<br>CO5 |
| LLO 15.1 Use plot/page setup commands in CADD for given drawings.<br>LLO 15.2 Create title block of the institute with institute logo. | 15 | Prepare a template for your institute of predefined paper size with title block and institute logo. | 4 | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 16.1 Use print and page setup commands in CADD for given drawings.<br>LLO 16.2 Take printout of given drawings by using print/plot option. | 16 | *Plot the drawings from Sr. 2 to 14 on Paper with title block and institute logo | 4 | CO1<br>CO2<br>CO3<br>CO4 |

**Note : Out of above suggestive LLOs -**

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

## VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

**Micro project**

- Prepare a drawing of actual machine part or a circuit diagram in the given CADD software. The students maybe assigned a machine part in a group of 4-5 students by the faculty. The student can bring any part from a nearby industry or from the institute itself. The suggested list of machine parts or circuit diagrams is given below. The list is

suggestive and faculty can add any other similar micro projects. a. PCB metal box b. Switch board c. Ladder diagrams d. Domestic/ office/ institute laboratory/ Generator wiring diagram

**Assignment**

- Maintain a separate folder on Computer workstation allotted, in which all above mentioned practical's should be saved and will be submitted as a part of SLA.
- Collect at least one 2D drawing like production / lab or machine wiring / PLC / circuit drawings or layouts from their own institute or nearby workshops / industries / builders / contractors and develop them using computer aided drafting approach.
- Explain at least one problem drawn by the student for drafting to all batch colleagues. Teacher will assign the problem to be explained by student.
- Create groups of 5-6 students identified by the teacher. Assign different problems to each group. Assess at least one 2D drawing of one group by the students of other group and note down mistakes committed by the group. Selected students will also guide other students for correcting mistakes, if any.

**Note :**

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

## VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

| Sr.No | Equipment Name with Broad Specifications | Relevant LLO Number |
|---|---|---|
| 1 | Networked Licensed latest version of Computer Aided Drafting software, Autocad 2021 or latest version, Ecad. | 1,2,3,4,5,6,7,8,9,10,15 |
| 2 | Circuit-Maker freeware for PCB design | 11,12,13,14,15 |
| 3 | Plotter/Printer with latest versions (A3/A4 size) Laserjet | 16 |
| 4 | CAD workstation with latest configurations for each student. Microsoft Windows 10 or above, with minimum i5 Processor (2.5 GHz) , 8 GB RAM ,512 SDD | All |
| 5 | LCD projector with at least 4500 lumens and aspect ratio 16:10. OR Screen/ Interactive board. | All |

## IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE

## X. ASSESSMENT METHODOLOGIES/TOOLS

**Formative assessment (Assessment for Learning)**

- Termwork Each practical will be assessed considering - 60% weightage to process and - 40% weightage to product Continuous assessment based on process and product related performance indicators, laboratory experience. The

students maybe given actual problems from laboratories like generator wiring, hydraulic/ pneumatic circuits of any equipment in the laboratory.

**Summative Assessment (Assessment of Learning)**

- Practical Exam of 25 marks.

## XI. SUGGESTED COS - POS MATRIX FORM

| 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 | PSO-3 |
| CO1 | 2 | 1 | 1 | 2 | - | - | 3 | | | |
| CO2 | 2 | 1 | 1 | 2 | - | - | 3 | | | |
| CO3 | 2 | 1 | 1 | 2 | - | 2 | 3 | | | |
| CO4 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | | | |
| CO5 | 3 | 2 | 2 | 2 | - | 2 | 3 | | | |

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

## XII. SUGGESTED LEARNING MATERIALS / BOOKS

| Sr.No | Author | Title | Publisher with ISBN Number |
|---|---|---|---|
| 1 | Prof. Sham Tickoo | AutoCAD 2021 for Engineers & Designers, Basic & Intermediate | BPB Publications, New Delhi 21 February 2021, ISBN: 978-9389898989 |
| 2 | Sankar Prasad Dey | Autocad 2014 for Engineers Volume 1 | Vikas Publications, New Delhi 21 December 2021, ISBN: 978- 9325983373 |
| 3 | Prof. Sham Tickoo | AutoCAD 2024: A Problem-Solving Approach, Basic and Intermediate | Dreamtech Press publication, New Delhi August 20, 2023, ISBN:1640571778 |
| 4 | Kulkarni D. M. | Engineering Graphics with AutoCAD | Prentice Hall India Learning Private Limited, New Delhi 1 January 2010, ISBN: 978-8120337831 |
| 5 | CADfolks | AutoCAD 2021 For Beginners | Kishore Publication, New Delhi, 5 May 2020, ISBN: 978-8194195399 |
| 6 | Luke Jumper, Randy H. Shih | AutoCAD 2024 Tutorial First Level 2D Fundamentals | SDC Publication, Kansas City USA June 27, 2023, ISBN: 978-1-63057-585-4 |
| 7 | Sharad K. Pradhan, K K Jain | Engineering Graphics , AICTE Prescribed Textbook | Khanna Book Publishing, New Delhi First Edition, 1 January 2023, , ISBN:978-9391505509 |
| 8 | MicroCode Engineering, Inc. | Circuitmaker User Manual | MicroCode Engineering, Inc. First edition, 1988-89 |

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## XIII . LEARNING WEBSITES & PORTALS

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | https://www.cadtutor.net/ | Tutorials, articles, forums and downloadable resources covering various CAD software applications. |
| 2 | https://ocw.mit.edu/courses/mechanical-engineering/ | Lectures, assignments and projects covering topics such as engineering design, CAD/CAM, and product development. |
| 3 | https://www.youtube.com/watch?v=cmR9cfWJRUU | Introductory tutorial for beginners to AutoCAD, covering topics such as interface navigation, basic drawing commands and setting up units and layers. |
| 4 | https://www.youtube.com/watch?v=QuR-VKis3jU | 2D mechanical drawings in AutoCAD, including drawing parts, adding dimensions, annotations and creating detailed technical drawings. |
| 5 | https://www.youtube.com/watch?v=IWYKfzx-M1E | 2D mechanical drawings in AutoCAD, including drawing parts, adding dimensions and annotations, and creating detailed technical drawings. |
| 6 | https://www.youtube.com/watch?v=N5VThCFG0Bs | Complete guide for learning Circuitmaker software. |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students