Department of Mechanical Engineering

P-23 Curriculum

(Sandwich Pattern)

# Semester-III

(Course Contents)

(2023-24)

**GOVERNMENT POLYTECHNIC, MUMBAI**

**(Academically Autonomous Institute, Government of Maharashtra)**

**Programme: Diploma in Mechanical Engineering (Sandwich Pattern)**

**Learning and Assessment Scheme (P23)** | **With Effect From Academic Year : 2023-24**

**Duration Of Programme : 6 Semester** | **Duration: 16 Weeks**

**Semester: Third** | **Scheme : P23**

| Sr. No. | Course Code | Course Title | Course Type | Total IKS Hrs for Sem | Learning Scheme | | | | | Credits | Assesment Scheme | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Actual Contact Hrs/Week | | | Self Learning (TW + Assignment) | Notional Lerning Hrs / Week | | Paper Duration (hrs.) | Theory | | | | | Based on LL & TL Practical | | | | | | Based on Self Learning SLA | | Total Marks |
| | | | | | | | | | | | | FA-TH | | SA-TH | Total | | FA-PR | | SA-PR | | SA-OR | | | | |
| | | | | | CL | TL | LL | | | | | T1 | T2 | Max | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | |
| | | | | | | | | | | | | Max | Max | | | | | | | | | | | | |
| **1** | UV23302 | Universal Human Values-II | VEC | 4 | 1 | - | - | 1 | 2 | 1 | - | - | - | - | - | - | - | - | - | - | - | - | 50 | 20 | 50 |
| 2 | ME23105 | Mechanical Measurment and Mechatronics | DSC | 1 | 4 | - | 2 | 2 | 8 | 4 | 2 Hrs 30Min | 20 | 20 | 60 | 100 | 40 | 25 | 10 | - | - | - | - | 25 | 10 | 150 |
| **3** | ME23106 | Strength of Mechanical Materials | DSC | 2 | 3 | - | 2 | - | 5 | 2.5 | 2 Hrs 30Min | 20 | 20 | 60 | 100 | 40 | 25 | 10 | - | - | - | - | - | - | 125 |
| 4 | ME23107 | Engineering Thermodynamics | DSC | 1 | 3 | - | 2 | - | 5 | 2.5 | 2 Hrs 30Min | 20 | 20 | 60 | 100 | 40 | 25 | 10 | - | - | - | - | - | - | 125 |
| **5** | ME23108 | Theory of Machines | DSC | 2 | 3 | - | 2 | 1 | 6 | 3 | 2 Hrs 30Min | 20 | 20 | 60 | 100 | 40 | 25 | 10 | - | - | - | - | 25 | 10 | 150 |
| 6 | ME23109 | Mechanical Engineering Drawing and CAD | DSC | 1 | - | - | 4 | 2 | 6 | 3 | - | - | - | - | - | - | 25 | 10 | 50# | 20 | - | - | 25 | 10 | 100 |
| **7** | ME23110 | Fluid Mechanics and Machinery | DSC | 2 | 4 | - | 2 | - | 6 | 3 | 2 Hrs 30Min | 20 | 20 | 60 | 100 | 40 | 25 | 10 | 25# | 10 | - | - | - | - | 150 |
| 8 | ME23301 | Environmental Studies | VEC | 1 | - | - | 2 | - | 2 | 1 | - | - | - | - | - | - | 25 | 10 | - | - | - | - | - | - | 25 |
| | | | | **10** | **18** | **0** | **16** | **6** | **40** | **20** | | **100** | **100** | **300** | **500** | **200** | **175** | **70** | **0** | **30** | **0** | **0** | **75** | **30** | **825** |

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 two class tests of 20 marks each conducted during 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 candidate shall be declared as fail & will have to repeat & resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.*15Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. *Self learning hours shall not be reflected in the TimeTable.

**Course Category :**

Discipline Specific Course (DSC): 6, Discipline Specific Elective (DSE): 0, Value Education Course(VEC): 2, Intern./Apprenti./Project./ Community(INP): 0, Ability Enhancement Course (AEC) : 0, Skill Enhancement Course (SEC) : 0, Inter Disciplinery Elective (IE) : 0

| Department Coordinator | Head of Department | In-Charge | Principal |
|---|---|---|---|
| Curriculum Development Cell | Department of Mechanical Engineering | Curriculum Development Cell | Government Polytechnic, Mumbai |

| **Programme : Diploma in ME/CE/EE/CO/IF/IS/EC/RT/LT/LG (Sandwich Pattern), AIML** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code: UV23302** | | | **Course Title : Universal Human Values-II** | | | | | | | | | |
| **Compulsory / Optional: Compulsory** | | | | | | | | | | | | |
| **Learning Scheme and Credits** | | | | | | **Assessment Scheme** | | | | | | |
| **CL** | **TL** | **LL** | **SLH** | **NLH** | **Credits** | **FA-TH** | **SA-TH** | **FA- PR** | **SA** | | **SLA** | **Total** |
| | | | | | | | | | **PR** | **OR** | | |
| 01 | – | – | 01 | 02 | 01 | – | – | – | – | – | 50 | 50 |

**Total IKS Hrs. for course: 04**

**Abbreviations:** CL- Classroom Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

**Note:**

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.

2. SA-TH represents the end term examination.

**Rationale:**

Universal Human Values-I course helped students to discover themselves and comfortably connect with their peers. Students experienced living in harmony with nature by visiting a nature park and participating in activities like tree plantation, beach cleaning and institute cleaning.

The Universal Human Values-II course is more focused on helping students to create health consciousness and experience living in harmony with their bodies. It will help to create a holistic perspective based on self-exploration about themselves, family, society and nature. Patriotic values will be imbibed by learning about the constitution of India.

Through experiential learning, an ideal personality will be developed to excel in the field of work. It is the journey of thought process from 'my family' to 'world family'. In essence, it promotes human values, inculcates ethics and develops the best citizens.

**Industry / Employer Expected Outcome:**

To demonstrate value based behavior at the workplace.

**Course Outcomes:**

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

| | |
|---|---|
| CO1 | Understand and appreciate duties and civic responsibilities. |
| CO2 | Develop health consciousness. |
| CO3 | Develop respect and recognition for others' work. |
| CO4 | Understand the importance of living in harmony with nature and society. |
| CO5 | Internalize lessons from great souls who exemplified nobility, courage and righteousness. |
| CO6 | Develop holistic well-being through balancing individual needs with common good. |

**Course Content Details:**

| Sr. No. | CO | Activity | Related Value/s | Methodology of Implementation | Student's Role | Mentor's role | Resources Required |
|---|---|---|---|---|---|---|---|
| 1 | CO1 CO3 | Read preamble of constitution and list down duties and responsibilities of a citizen | Patriotism Integrity Loyalty Harmony Righteousness | Read preamble of constitution of India from internet website | Brainstorm to understand the importance of preamble. | Motivate students to present different stories related to Indian constitution | https://www.constitutionofindia.net/constitution_of_india/preamble |
| 2 | CO6 | Prepare your own SWOT Analysis | Self-exploration, Honesty | Analysis and report writing | Thoughtfully analyze self | Explain process of SWOT analysis | Case studies |
| 3 | CO2 | Student will prepare a diet chart, analyze food consumption habit-List food consumed during last 3 days and identify its nutritional effects on body | Health consciousness | Balanced diet chart preparation | Find out the ways to maintain balanced diet chart | Provide information resources | Internet websites, Professional dietician |
| 4 | CO3 CO5 | Identify 5 personalities from the areas like sports, defense, politics,, businesses and social workers who have demonstrated great spirit of integrity in their life and write a report. e.g. **Rajendra singh**- Water man of india, **Dr. A P J Abdul kalam**- scientist and former president of india. **Mohammed Yunus**- Bangladeshi social entrepreneur, **Kapil Dev**-Cricketer of the century. **David Packard**- Chairman of Hewlett-Packard (HP) | Integrity , respect | Information collection and analysis | Identify personalities and study their extraordinary work | Guide students to identify various dimensions of the personality | Internet websites, Institute Library |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5 | CO4 CO6 | Study the Sustainable Development Goals of the United Nations for peace and prosperity of people and the planet, now and into the future by visiting the following website: https://sdgs.un.org/goals | Social Gratitude, Empathy, Compassion, Accountability | Visit the website, study history and List 17 SDGs | Study the sdg in detail (assigned to your group by mentor), prepare presentation | Assign 17 SDGs to different groups of students | Local NGOs working for UN |
| 6 | CO2 CO6 | Understanding Eight limbs (Ashtanga) of Yoga for gaining the best mental health.<br><br>**IKS hours**- Cultural and spiritual history of India- eight fold path of yoga. | Health consciousness Social gratitude | Arrange the session of a meditation expert to understand the philosophy of Yoga. | Students will need to understand and practice the principles of the eight limbs of yoga. Practice it daily for the best physical and mental health. | Mentors will need to provide guidance on understanding and practicing the principles of the eight limbs of yoga and provide feedback on students' progress. | Resources such as yoga mats or printed materials on the eight limbs of yoga may be required. |
| 7 | CO5 | 1.Seven blunders told by Mahatma Gandhi and practice them as an ethic in your daily life to be a moral citizen.<br>2. Swami Vivekananda and his philosophy<br>3.Bharatratna Dr Babasaheb Ambedkar and his philosophy, teachings<br>Any other social reformer<br><br>**IKS hours**- Cultural history of India- Religious and Civic philosophies. | Character Humanity Sacrifice Honesty<br><br>Accountability Patriotism | Select any one topic. Prepare Group presentations on selected topics. | Students will need to prepare and present a group presentation on a selected topic. | Mentors will need to provide guidance on preparing and presenting a group presentation and provide feedback on students' presentations. | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | CO3 CO6 | Visit websites of reputed industries and study their Corporate Social Responsibility (CSR) activities. Also arrange an interview of a successful entrepreneur. | Social Gratitude Accountability | Visit CSR section of the website of selected industry | Students will need to research and report on the CSR activities of a selected industry. | Mentors will need to provide guidance on researching and reporting on CSR activities and provide feedback on students' reports. | Access to the internet or relevant industry publications may be required. |
| 9 | CO3 | Analyze behavior pattern of self and group member while performing any group activity | Harmony in behavior | List different group activities, select anyone from the list and perform it. | Students will need to analyze their own behavior and that of their group members during a group activity and record their observations. | Mentors will need to provide guidance on observing and recording behavior patterns and provide feedback on students' observations. | Guidelines for observing and recording behavior patterns may be necessary. |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10 | CO5 | Read and create abstract of biography like,<br>1. Ek Hota Carver<br>2.Biography of a yogi<br>3. JRD Tata<br>4. Mahatma Gandhi<br>5. Pant pratinidhi<br>6. Shriman Yogi | Righteousness | Visit library, find out books, read and prepare the report | Students will need to select a biography to read and create an abstract that summarizes the key ideas and messages in the biography. | Mentors will need to provide guidance and support to help students select an appropriate biography and create a well-written abstract. | Access to a library or online resources to select a biography to read and create an abstract. |
| 11 | CO1<br>CO3<br>CO4 | NDRF one day training OR Police Mitra training OR Red cross training OR Fire safety training OR Self defense training for Girls OR CPR training | Accountability<br>Empathy | Plan training with the help of related agencies | Students will need to attend a one-day training session. | Mentors will need to provide guidance on attending the selected training session and ensuring safety. | Access to training facilities and materials may be necessary. |



**Methodology:**

1. The course teacher will be the mentor.
2. In consultation and under supervision of a mentor, the student/ Group of students has to complete the activity.
3. The mentor will work as a facilitator/ advisor.
4. The strategies to learn the course is "Self- Exploratory" and "Experiential Learning"
5. The onus of responsibility for completing the activities is with students.
6. **Out of eleven activities the student has to complete at least five no. of activities throughout the term. Activity number two is compulsory.**

**Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):**

During self learning hours students have to register online **(https://www.mahayouthnet.in/)** for the following "Youth Leadership for Climate Action" self-paced online courses. After completion of these courses students will appear for the online exam of these courses and earn a certificate of completion. Students will submit these 4 certificates to the mentor.

| Sr. No. | Unit | Marks |
|---|---|---|
| 1 | Living with Climate Change | 10 |
| 2 | Water Management and Climate Action | |
| 3 | Energy Management and Climate Action | 05 |
| 4 | Waste Management and Climate Action | 05 |
| 5 | Bio-cultural diversity Conservation and Climate Action | 05 |
| 6 | The student has to complete at least **five** no. of activities out of the 11 activities mentioned in the course content details throughout the term and submit the reports. Each activity carries 05 marks. | 25 |
| | Total | 50 |

**Note: 1. Unit 1 and Unit 2 are presented together and carry one certificate.**
**2. Unit 3,4, and 5 are individual units.**



## Assessment methodologies/Tools:

### Formative Assessment(Assessment for Learning)

The student has to complete at least **five** no. of activities throughout the term. Each activity carries 05 marks.

| Criterion No. | Criterion | Max. Marks | Not Satisfactory | Good | Excellent |
|---|---|---|---|---|---|
| 1 | Attendance | 01 | 0 | 1 | 1 |
| 2 | Knowledge | 02 | 0 | 1 | 2 |
| 3 | Presentation / Performance | 02 | 0 | 1 | 2 |
| | Total | 05 | | | |

## Suggested CO-PO 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, Experimentation and Testing | 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 | | | |
| CO2 | - | 1 | 1 | - | - | - | 1 | | | |
| CO3 | - | 1 | - | - | - | - | 2 | | | |
| CO4 | - | 1 | 1 | - | 1 | - | 2 | | | |
| CO5 | - | - | - | - | - | - | 3 | | | |
| CO6 | - | 1 | 1 | - | - | - | 2 | | | |
| Legends :- High:03, Medium:02,Low:01, No Mapping: -<br>*CO PSOs mapping to be formulated at department level | | | | | | | | | | |

**References/ Books:**

| Sr. No. | Title | Author, Publisher, Edition and Year Of publication | ISBN |
|---|---|---|---|
| 1 | A Foundation Course in Human Values and Professional Ethics | R.R. Gaur, R. Sangal, G.P. Bagaria, Excel Books, New Delhi, 2010 | 978-8-174-46781-2 |
| 2 | Human Values | A.N. Tripathy, New Age International Publishers, 2003 | 978-8-122-42589-5 |
| 3 | Teacher's Manual - A Foundation Course in Human Values and Professional Ethics | R.R. Gaur, R. Sangal, G.P. Bagaria, Excel Books, New Delhi, 2010 | - |
| 4 | Science and Humanism, Towards a Unified World View | PL Dhar, RR Gaur, Commonwealth Publications, 1992 | 978-8-171-69222-4 |
| 5 | Education for values in schools- a framework | NCERT | |
| 6 | Value oriented education | E N Gawande | |

**E-References:**

1) **https://youtu.be/kOJu1vj_BVk (The 10 MostImportant Human Values)**
2) **Dr. Prakash Baba Amte- Movie**
3) **https://youtu.be/QeogOlzG2ls (Value of Education -short film)**

**E-References for mentors:**

1) **https://www.edutopia.org/**

**2)** **https://sdgs.un.org/goals**

**3)** **https://www.mahayouthnet.in/**

**Consultation Committee:**

| Sr. No | Name | Designation | Institute/Organisation |
|---|---|---|---|
| 1 | Dr. L.A. Patil | Principal (Retired) | Pratap College, Amalner |
| 2 | Dr. Nitin Deshpande | Lead Consultant | Dnyanpeeth Academy, Pune |
| 3 | Dr. Chandrakant Shahasane | Founder Trustee | Karnala Charitable Trust, Pune |
| 4 | Mr. K. V. Patil | Lecturer, Mechanical Engineering | Government Polytechnic, Mumbai |
| 5 | Mrs. P. A. Khande | Lecturer, Electronics Engineering | Government Polytechnic, Mumbai |
| 6 | Mrs. Vrushali A. Patil | Lecturer, Computer Engineering | Government Polytechnic, Mumbai |
| 7 | Mrs. Sanjana Londhe | Lecturer,Civil Engineering | Government Polytechnic, Mumbai |
| 8 | Mrs. Swati Shinde | Lecturer,Instrumentation Engineering | Government Polytechnic, Mumbai |

Institute Coordinator, Principal

Curriculum Development, Government Polytechnic, Mumbai

| **Programme : Diploma in Mechanical Engineering** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code: ME23105** | | | | | | **Course Title: MECHANICAL MEASUREMENT AND MECHATRONICS** | | | | | | | |
| **Compulsory / Optional: Compulsory** | | | | | | | | | | | | | |
| **Learning Scheme and Credits** | | | | | | **Assessment Scheme** | | | | | | | |
| **CL** | **TL** | **LL** | **SLH** | **NLH** | **Credits** | **FA-TH** | | **SA-TH (2:30 Hrs.)** | **FA-PR** | **SA** | | **SLA** | **Total** |
| | | | | | | **T1** | **T2** | | | **PR** | **OR** | | |
| 4 | -- | 2 | 2 | 8 | 4 | 20 | 20 | 60 | 25 | -- | -- | 25 | 150 |

**Total IKS Hrs. for course: 01 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, SLA- Self Learning Assessment
**Legends:** @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination
**Note:**
1. FA-TH represents Total of two class tests of 20 marks each conducted during the term.
2. FA-PR represents Term work of 25 Marks
3. SLA represents self-learning Assessment of 25 Marks
4. SA-TH represents the end term examination of 60 Marks

## I. Rationale

Measurement activities are given prime importance in industry. The art of measurement plays an important role in all branches of engineering. With advances in technology, measurement techniques have also taken rapid strides, with many types of instrumentation devices, innovations, refinements. The course aims at making a Mechanical Engineering student familiar with the principles of instrumentation, transducers & measurement of non-electrical parameters like temperature, pressure, flow, speed, force and stress. The integration of Mechanical Engineering, Electrical Engineering, Electronics Engineering, Computer Technology and Control Engineering is increasingly forming a crucial part in the design, manufacture and maintenance of wide range of engineering products and processes. As a consequence there is a need for a diploma engineers to understand systems used in Mechatronics.

## II. Industry / Employer Expected Outcome

To imagine, understand and use the measurement instruments and concept of mechatronics.

## III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning.

| | |
|---|---|
| CO1 | Understand the working principle and characteristics of measuring instruments |
| CO2 | Select the transducer for measurement of displacement, speed and strain for various applications. |
| CO3 | Select and operate the instrument for measurement of temperature and flow. |
| CO4 | Identify the key elements of a Mechatronics system. |

| | |
|---|---|
| CO5 | Use the different types of control systems and controllers used in mechatronics. |
| CO6 | Use the PLC functions for different automation applications.. |

**Course Content Details:**

| Unit No. | Theory Learning Outcomes (TLO's) aligned toCO's. | Topics / Sub-topics |
|---|---|---|
| **1** | TLO 1.1 Explain the working of generalised measurement system.<br>TLO 1.2 Understanding static and dynamic characteristics | **Unit-I Significance of Measurement**<br>1.1 Significance of measurement: classification of instruments, static terms and characteristics- range and span, accuracy and precision, reliability, calibration, hysteresis and dead zone, drift, sensitivity, threshold and resolution, repeatability and reproducibility, linearity.<br>1.2 Dynamic characteristics- speed of response, fidelity and dynamic errors, overshoot. Measurement of error- classification of errors.. |
| | **Course Outcome : CO1** **Teaching Hours : 08** **Marks: 08** | |
| **2** | 2.1 Explain the working of displacement and speed measuring instruments.<br>2.2 Select the transducer for measurement of displacement, speed and strain for various applications. | **Unit- II Displacement, Speed and Strain Measurement**<br>2.1 Displacement measurement: Potentiometer, LVDT, RVDT.<br>2.2 Speed measurement - Mechanical Tachometers, Electrical Tachometers, Inductive Pick Up, Capacitive Pick Up, and Stroboscope.<br>2.3 Strain Measurement: - types of strain gauges, resistance strain gauge bonded and unbounded, types (foil, semiconductor, and wire wound gauges), selection and installation of strain gauges, load cells. |
| | **Course Outcome : CO2** **Teaching Hours : 10** **Marks: 12** | |
| **3** | 3.1 Explain the working of various temperature measuring instruments<br>3.2 Know the working of various flow measuring instruments<br>3.3 Select and operate the instrument for measurement of flow | **Unit-III Temperature and Flow Measurement**<br>3.1 Non-electrical methods: bimetal and liquid in glass thermometer, pressure thermometer<br>3.2 Electrical methods: RTD, platinum resistance thermometer, thermistor<br>3.3 Radiation Methods: radiation and optical Pyrometers.<br>3.4 Flow measurements: Variable head flow meters, variable area meter Rota meter,<br>3.5 Anemometer- hot wire and hot film, electromagnetic flow meter, ultrasonic flow meter. |
| | **Course Outcome : CO3** **Teaching Hours : 10** **Marks: 10** | |
| **4** | 4.1 Identify the need of Mechatronics<br>4.2 Know the role of Mechatronics in various sectors Identify the different types of sensors and actuators<br>4.3 Describe the working of DC & AC motors | **Unit-IV: Elements of Mechatronics**<br>4.1 Introduction to Mechatronics<br>4.2 identification of key elements of mechatronics systems and represent into block diagram (Electro-Mechanical Systems), Concept of transfer function<br>4.3 Advantages, disadvantages & applications of Mechatronics system<br>4.4 Potentiometer sensor, Proximity sensor, Eddy current proximity sensor, Inductive proximity sensor, Optical encoder, Pneumatic sensor, Piezoelectric sensor, Tactile sensor, Light sensor<br>4.5 Limit switches, Thumb wheel switches, Relays, Solenoids<br>4.6 DC motor, Brushless DC motor, AC motor, Stepper motor and Servo motor |
| | **Course Outcome : CO4** **Teaching Hours : 12** **Marks: 10** | |

| | | |
|---|---|---|
| **5** | 5.1 Identify different types of control systems<br>5.2 Know about network, microcontrollers, Internet of Things and Artificial Intelligence | **Unit-V**: **Controllers and Control Systems**<br>5.1 Open-loop and closed-loop control<br>5.2 Feedback control systems<br>5.3 Feed forward control system<br>5.4 On–off control<br>5.5 Proportional Derivative and integral control system<br>5.6 PID control system<br>5.7 Pneumatic and electronic controllers<br>5.8 Microcontrollers |
| | **Course Outcome : CO5** **Teaching Hours : 10** **Marks: 10** | |
| **6** | 6.1 Identify the PLC type<br>6.2. State the uses of PLC<br>6.3 State the difference between microprocessor and microcontroller | **Unit-VI**: **Programmable Logic Controller (PLC)**<br>6.1 Introduction, PLC definition, PLC block diagram, Difference between relay panel and PLC,<br>6.2 Input/output modules (Analog, digital), concepts of sink/source, latch/unlatch, advantages and disadvantages of PLC<br>6.3 Installation, troubleshooting and maintenance of PLC<br>6.4 Networking of PLC<br>6.5 Online, offline, stop / run modes of operations, uploading / downloading between PLC and PC |
| | **Course Outcome : CO6** **Teaching Hours : 10** **Marks: 10** | |

**IV. 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 Select contact and non-contact type instruments as per given situation. | 1 | Identify contact and non-contact type Instruments. | 04 | CO1 |
| LLO 2.1 Measure Force and weight using a load cell. | 2 | Verify Force and weight using a load cell. | 04 | CO2 |
| LLO 3.1 Measure flow of various fluids. | 3 | Flow Measurement through pipe using Rotameter. | 04 | CO3 |
| LLO 4.1 Select appropriate temperature measurement device as per situation. | 4 | Assignment on temperature measurement. | 04 | CO2 |
| LLO 5.1 Understand Mechatronics system | 5 | Identify different types of Mechatronics system built in automated machine tools | 02 | CO4 |
| LLO 6.1 Understand different type of sensors and their working. | 6 | Identify different types of sensors and actuators of any automation system | 02 | CO4 |
| LLO 7.1 understand working of AC & DC motors | 7 | Identify different types of DC and AC motors applications | 02 | CO5 |
| LLO 8.1 Understand various types of control systems | 8 | Identify different types of control systems for various applications | 04 | CO5 |
| LLO 9.1 Understand Maintenance of PLC and apply the knowledge | 9 | Maintenance of PLC of any automation system available in the lab | 04 | CO6 |

**Note:** All Experiments/Assignments are compulsory.

**Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):**

| Sr. | Assignment |
|---|---|

| No. | |
|---|---|
| 1 | Prepare /Download a specification of followings:<br>a. Measuring Tools and equipment in measurement laboratory.<br>b. Machineries in measurement laboratory. |
| 2 | Visit to any Tool room and observe the working of inspection and testing department. also prepare a report consisting<br>a. Different advanced measuring Instruments.<br>b. Different Measuring standards and calibration process<br>c. Care and maintenance of measuring instruments observed. |
| 3 | Collect the information of different types of sensors from online resources. |
| 4 | Search the information of automation industries through internet. |
| 5 | Collect the information about automation modules for material handling applications. |
| 6 | Search information about electro pneumatic systems used in automation system |

## V. Specification Table:

| Unit No | Topic Title | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|
| | | R Level | U Level | A Level | Total Marks |
| 1 | Significance of Measurement | 2 | 4 | 2 | 08 |
| 2 | Displacement, Speed and Strain Measurement | 2 | 6 | 4 | 12 |
| 3 | Temperature and Flow Measurement | 2 | 4 | 4 | 10 |
| 4 | Elements of Mechatronics | 2 | 4 | 4 | 10 |
| 5 | Controllers and Control Systems | 2 | 4 | 4 | 10 |
| 6 | Programmable Logic Controller (PLC) | 2 | 4 | 4 | 10 |
| | **Total** | | | 60 | 60 |

## VI. Assessment Methodologies/Tools

### Formative assessment (Assessment for Learning)

Each sheet/ self-learning assignment to be assessed on following rubrics (10 marks)

| Attendance & Regularity | Technical Understanding | Presentation & completion | Total |
|---|---|---|---|
| 02 Marks | 04 Marks | 04 Marks | 10 Marks |

### Summative Assessment (Assessment of Learning)

- **TH -** Term End examination of 60 Marks

**VII. 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** |
| CO1 | 03 | 01 | -- | 02 | -- | -- | 01 | 01 | 01 |
| CO2 | 03 | 02 | -- | 03 | -- | -- | 01 | 01 | 01 |
| CO3 | 03 | 02 | -- | 03 | -- | -- | 01 | 02 | 02 |
| CO4 | 03 | 01 | -- | 01 | -- | -- | 01 | 01 | 01 |
| CO5 | 03 | 01 | -- | 01 | -- | -- | 01 | 02 | 02 |
| CO6 | 03 | 03 | 02 | 02 | -- | -- | 01 | 02 | 02 |
| Legends: - High:03, Medium:02, Low:01, No Mapping: -- | | | | | | | | | |

**VIII. Suggested Learning Materials / Books**

| Sr.No | Author | Title | Publisher |
|---|---|---|---|
| 1 | A. K. Sawhney | Mechanical Measurement and Instrumentation | Dhanpat Rai and Sons, New Delhi |
| 2 | E. O. Doebelin | Measurement System | TATA McGraw Hill |
| 3 | R. K. Jain | Mechanical and Industrial Measurement | Khanna Publications New Delhi |
| 4 | K.L.Narayan, P.Kannaiah | Textbook on engineering drawing | Scitech publications, 24th reprint, 2010, ISBN-978-8183-7142-28 |
| 5 | Bolton W | Mechatronics-Electronic control systems in Mechanical and Electrical Engineering | Pearson Education Ltd |
| 6 | Histand B. H. & Alciatore D. G | Introduction to Mechatronics and Measurement systems | Tata McGraw Hill Publishing |
| 7 | John W. Webb & Ronald Reis | Programmable Logic Controllers | Prentice Hall of India |
| 8 | NIIT | Programmable Logic Control,Principles and Applications | Prentice Hall of India |

## IX. Learning Websites & Portals

| Sr .No | Link /Portal | Description |
|---|---|---|
| 1 | https://www.youtube.com/watch?v=Z6evuxYjYMs&list=PLSGws_74K019wiWyVU3CnVMMqAcF3_sxz | Audio visual videos for different experiments on YouTube. |
| 5 | http://www.automationworld.com/ | For Automation videos of Mechatronics |
| 6 | http://www.rockwellautomation.com/ | For Automation videos of Mechatronics |
| 7 | http://www.automation.com/ | For Automation videos of sensor |
| 8 | http://www.rethinkrobotics.com/ | For Automation videos of sensor |

## X. Academic Consultation Committee/Industry Consultation Committee:

| Sr. No | Name | Designation | Institute/Organization |
|---|---|---|---|
| 1 | Mr. Gopal Patil | Sr. Lead Engineer | Stellantis India Ltd. , Pune |
| 2 | Mr. Manoj Thakur | Lecturer in Mechanical Engineering | Government Polytechnic, Dhule |
| 3 | Mr. E. C. Dhembare | Lecturer in Mechanical Engineering | Government Polytechnic Mumbai |
| 4 | Mrs. A. N. Naik | Lecturer in Mechanical Engineering | Government Polytechnic Mumbai |

Coordinator,
Curriculum Development,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal

| **Programme : Diploma in Mechanical Engineering** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code: ME23106** | | | | | **Course Title : Strength of Mechanical Materials** | | | | | | | | |
| **Compulsory / Optional: Compulsory** | | | | | | | | | | | | | |
| **Learning Scheme and Credits** | | | | | | **Assessment Scheme** | | | | | | | |
| **CL** | **TL** | **LL** | **SLH** | **NLH** | **Credits** | **FA-TH** | | **SA-TH (2.5 Hrs.)** | **FA - PR** | **SA** | | **SLA** | **Total** |
| | | | | | | | | | | **PR** | **OR** | | |
| 3 | -- | 2 | 1 | 6 | 3 | 20 | 20 | 60 | 25 | -- | -- | 25 | 150 |

**Total IKS Hrs. for course: 2hrs.**

**Abbreviations:** CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

**Note:**

1. FA-TH represents an average of two class tests of 30 marks each conducted during the term.
2. SA-TH represents the end term examination.
3. FA-PR represents the term work.
4. SA-PR represents the end term practical examination.

## I. Rationale

Diploma holders in this course are required to analyze reasons for failure of different components and select the required materials for different applications. For this purpose, it is essential to teach them concepts, principles, applications and practices covering stress, strain, bending moment, shearing force, shafts, columns and springs. Hence this subject has been introduced. It is expected that efforts will be made to provide appropriate learning experiences in the use of basic principles to the solution of applied problems to develop the required competencies.

## II. Industry / Employer Expected Outcome

Strength of material is crucial in designing Mechanical Components and Structures that can withstand stress and load. With this knowledge, engineers can select appropriate materials and determine their sizes and shapes for specific applications.

**III. Course Outcomes:** Students will be able to achieve & demonstrate the following COs on completion of course based learning

| | |
|---|---|
| CO1 | Analyze/compare various mechanical properties and develop theoretical basics for axial loading, bending and buckling. |
| CO2 | Calculate principal stresses using analytical and graphical Mohr's circle diagram |
| CO3 | Solve moment of inertia for different sections, section modulus and bending stress. |
| CO4 | Draw shear force diagram & bending moment diagram and calculating slope/deflection for the structural components subjected to lateral loading. |
| CO5 | Analyze direct/bending stresses, Eccentric and Buckling load. |
| CO6 | Evaluate strain energy stored in the element subjected to gradual/sudden/impact loads and numerical on torsional shear stress |

**IV. Course Content Details:**

| Unit No. | Theory Learning Outcomes (TLO's)aligned to CO's | Topics / Sub-topics |
|---|---|---|
| **1** | **TLO 1a:** Definition of important mechanical properties of materials, stress, strain, elastic, plastic and rigid bodies<br>**TLO 1b:**, Explain Hooke's Law, Young's modulus, Lateral Strain & Poisson's Ratio<br>**TLO 1c:** Explain Stress Strain Curve<br>**TLO 1d**: Concept of Thermal stresses and strains<br>**TLO 1e**: Defining Factor of Safety<br>**TLO 1f.** Defining Buckling Failure for Columns | **Mechanical Properties of Materials , Simple Stresses and Strains**<br>1.1 Mechanical properties: Elasticity, Plasticity, Ductility, Brittleness, Malleability, Fatigue, Creep, Toughness, Hardness; Definition of elastic, plastic and rigid bodies, concept of deformation, stresses and strains.<br>1.2. Axial tensile and compressive load, Hooke's Law, Young's modulus, axial stress, axial strain, Modulii of elasticity Linear and lateral strain, Poisson's ratio, changes in lateral dimension.,<br>(problems on bars of uniform and stepped cross section, elastic modulii).<br>1.3. Behavior of mild steel under tensile loading, stress-strain curve along with important points for ductile and brittle materials. Factor of safety, safe stress, working stress.<br>1.4 Concept of thermal stresses and strains, nature of stresses, simple problems on temperature stresses on homogenous sections only.<br>1.5 Concepts of Buckling – Rankine's & Euler's formulae for buckling load for columns / shafts under compression, concepts of equivalent length for various end conditions<br>**Course Outcome: CO1,**<br>**Teaching Hours:10 hrs ,**<br>**Marks:12 (R-2, U-4, A-6)** |

| | | |
|---|---|---|
| **2** | **TLO2a.** Defining principal planes, stresses, oblique plane and obliquity<br>**TLO2b.** Explaining Mohr's Circle for and calculating principal stresses graphically | **Principal planes & Principal stresses**<br>**2.1** Concept of principal planes & stresses. Definition of principal planes, principal stresses, oblique plane and obliquity.<br>**2.2** Different states of stresses, normal & tangential stress on oblique plane, resultant stress.<br>**2.3** Analytical and graphical method (Mohr's Circle) for locating principal plane and calculating principal stresses for uniaxial/biaxial loading.<br>**Course Outcome: CO2**<br>**Teaching Hours : 6**<br>**Marks: 10 (R-2, U-4, A-4)** |
| **3** | **TLO3a.** Concept of moment of inertia,<br>**TLO3b.** Concept of Parallel axis, Perpendicular axis theorem<br>**TLO3c.** Defining Bending and Theory of Bending | **Moment of Inertia & Bending stresses**<br>**3.1 Moment of Inertia**<br>3.1.1 Moment of Inertia (M I): M.I. for plane areas, radius of gyration, M.I for regular plane areas<br>3.1.2 Rectangle, triangle, circle, semi-circle, hollow rectangular and hollow circular section.<br>3.1.3 Parallel axes theorem & Perpendicular axes theorem ( no derivation)<br>3.1.4 M.I of symmetrical and unsymmetrical I sections, channel and angle sections and T section. M.I of built up sections symmetrical and unsymmetrical about centroidal axis.<br>**3.2 Bending stresses**<br>3.2.1 Theory of simple bending, equation of bending.<br>3.2.2 Assumptions in the theory of bending, moment of resistance, section modulus & neutral axis. Simple numerical.<br>3.3 **Thin Cylindrical Vessels**<br>3.3.1 Introduction to Pressure Vessels, Stresses in Thin Cylindrical Shells (Circumferential, Longitudinal & Shear Stresses). Simple Numerical<br>**Course Outcome: CO3**<br>**Teaching Hours: 8**<br>**Marks: 10(R-2, U-4, A-4)** |

| | | |
|---|---|---|
| 4 | **TLO4a.** Concept of Beams , Shear force and Bending moment<br>**TLO4b.** Concept and Sign Conventions for SFD and BMD. | **Shear Force & Bending Moment**<br>4.1 Types of beams, types of supports, concept and definition of Shear force (S.F) and bending moment (B.M).<br>4.2 S.F and B.M diagrams for simply supported, overhang beams subjected to point load & UDL. Location of point of contraflexure and maximum bending moment calculations (if any).<br>( No problem to be set for External moment or couple),<br>4.3 S.F and B.M diagrams for cantilever subjected to point load & UDL. Location of point of contraflexure and maximum bending moment calculations (if any).<br>(No problem to be for External moment or couple)<br><br>**Course Outcome: CO4**<br>**Teaching Hours: 10**<br>**Marks: 12 (R-2, U-6, A-4)** |
| 5 | **TLO 5a.**. Concept of eccentric load and effects of eccentricity<br>**TLO 5b.**. Concept of Core of Section and Limiting eccentricity<br>**TLO 5c**. Concept of No tension condition. | **Direct and bending stresses**<br>5.1 Concept of direct and bending stresses, section modulus.<br>5.2 Eccentric loads, core or kernel of section, middle third rule, middle fourth rule.<br>5.3 Members of uniform sections subjected to eccentric loads with eccentricity and stress distribution at the base.<br>5.4 Structure subjected to horizontal, vertical loads e.g. tie bars, columns etc.<br><br>**Course Outcome: CO5**<br>**Teaching Hours: 6**<br>**Marks: 8 (R-0, U-4, A-4)** |
| 6 | **TLO5a.**: Definition of Strain Energy, and Different types of Loading in strain energy.<br>**TLO5b.**: Concept & Applications of Torsion<br>**TLO5c.**.Understanding Torsion Equation and its usage. | **Strain Energy & Torsion**<br>**6.1 Strain Energy**<br>6.1.1 Definition and Concept of Strain energy,<br>6.1.2 Types of loading gradual, sudden & Impact loading.<br>6.1.3 Stresses developed due to gradual, sudden & impact load.<br>6.1.4 Strain energy stored due to gradual, sudden & impact loading.<br>6.1.5 Resilience, proof resilience and modulus resilience.<br>**6.2 Torsion**<br>6.2.1 Stresses, strain & deformations in determinate shafts of solid & hollow,<br>Homogeneous & composite circular cross section subjected to twisting moment.<br>6.2.2 Derivation of torsion equation. Simple Numericals<br><br>**Course Outcome: CO6**<br>**Teaching Hours: 7**<br>**Marks: 10 (R-2, U-4, A-4)** |

## V. Suggested Micro Project / Assignment/ Activities for Specific Learning / SkillsDevelopment (Self Learning):

1 Tensile test on Mild steel/ Aluminium specimen, plotting of stress strain curve and indicating significant point as per I.S. requirement
2 Izod impact test on M.S., Copper, Aluminum and Brass
3 To find principal stresses and to locate principal plane using Mohr circle method and validate the same with numerical method. (Two different cases)
4 Bending test on mild steel/timber.
5 Assignment on Moment of Inertia & Bending stresses.
6 To draw shear force and bending moment diagram for different kinds of loads
7 Assignment on Direct and bending stresses.
8 Assignment on Strain Energy & Torsion.
9 Shear test – Single and double shear for mild steel bar
10 Deflection test on timber / metal specimen
11 Torsion test on metal bar
12 Hardness test (Brinell Hardness) on various metals.
13 Compression testing on metal/timber.

## VI.Suggested Specifications Table (Theory):

| Unit No | Topic Title | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|
| | | R Level | U Level | A Level | Total Marks |
| 1 | **Mechanical Properties of Materials, Simple stresses & Strains** | 2 | 4 | 4 | 10 |
| 2 | **Principal planes & Principal stresses** | 2 | 4 | 4 | 10 |
| 3 | **Moment of Inertia & Bending stresses** | 2 | 4 | 4 | 10 |
| 4 | **Shear Force & Bending Moment** | 2 | 6 | 4 | 12 |
| 5 | **Direct and bending stresses** | - | 4 | 4 | 08 |
| 6 | **Energy & Torsion** | 2 | 4 | 4 | 10 |
| | **Total** | **10** | **26** | **24** | **60** |

**Suggested COs - POs Matrix Form**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 2 | 1 | -- | 3 | 2 | 2 | 3 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 3 | 2 | 3 |
| **CO3** | 2 | 3 | 3 | 3 | 2 | 1 | 2 | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 3 | 2 | -- | -- | 3 | 3 | 2 | 2 |
| **CO5** | 3 | 3 | 3 | 3 | -- | -- | 2 | 2 | 2 | 3 |
| **CO6** | 3 | 3 | 3 | 3 | -- | -- | 3 | 2 | 3 | 2 |

## I. Suggested Learning Materials / Books

| Sr. No. | Title | Author, Publisher, Edition and Year Of publication | ISBN |
|---|---|---|---|
| 1 | Strength of Materials | S. Timoshenko, ( D. Van Nostntnd Company Inc.) | 978-1124155098 |
| 2 | Strength of Materials | R.K, Bansal . ( Laxmi Publication pvt ltd.) | 978-8131808146 |
| 3 | Strength of Materials | R. K. Rajput . ( S. Chand & Company Ltd.) | 9789352533695 |
| 4 | Strength of Materials | S. Ramamrutham. (Dhanpat Rai and sons Publishing House) | 9789384378264 |

**Academic Consultation Committee/Industry Consultation Committee:**

| Sr.No | Name | Designation | Institute/Organization |
|---|---|---|---|
| 1 | Mr. C.R.Khaire | Lecturer (Selection Grade) | K.J.Somaiya Polytechnic Mumbai |
| 2 | Mr. Rajendra.P. Sanap | Industry Expert | Signode India Limited |
| 3 | Mr.Bajirao K.Kakad | Head of Department (Applied Mechanics) | Govt. Polytechnic Mumbai |
| 4 | Mr.Mangesh.A.Jadhav | Lecturer in Applied Mechanics Dept. | Govt. Polytechnic Mumbai |

Coordinator,
Curriculum Development,
Mechanical Engineering Department

Head of Department
Mechanical Engineering Department

I/C, Curriculum Development Cell

Principal

| **Programme : Diploma in Mechanical Engineering (Sandwich Pattern)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code: ME23107** | | | | | **Course Title: Engineering Thermodynamics** | | | | | | | | |
| **Compulsory / Optional: Compulsory** | | | | | | | | | | | | | |
| **Learning Scheme and Credits** | | | | | | **Assessment Scheme** | | | | | | | |
| **CL** | **TL** | **LL** | **SLH** | **NLH** | **Credits** | **FA-TH** | | **SA-TH (2Hrs 30mins.)** | **FA-PR** | **SA** | | **SLA** | **Total** |
| | | | | | | **T1** | **T2** | | | **PR** | **OR** | | |
| **3** | **--** | **2** | **--** | **5** | **2.5** | **20** | **20** | **60** | **25** | **--** | **--** | **--** | **125** |

**Total IKS Hrs. for course: 01 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, SLA- Self Learning Assessment

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

**Note:**

1. FA-PR represents Term work of 25 Marks

**I. Rationale:** Engineering Thermodynamics is one of the core engineering subjects for mechanical engineering students. A diploma holder is supposed to handle steam generators, turbines, compressors, IC engines, refrigerators and other power plant equipment. Therefore, it is essential to impart them basic concepts of thermodynamics, steam generators, steam turbines, and heat exchangers. This course will enable students to establish foundation required to design, operate and maintain these devices.

**II. Industry / Employer Expected Outcome:**

To study the basic concepts of Engineering Thermodynamics and subsequently understand working of all the heat exchanging devices and be able to handle them securely and confidently.

**III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning.**

| | |
|---|---|
| CO1 | Describe the basic concepts of thermodynamics. |
| CO2 | Apply gas laws for given processes. |
| CO3 | Describe the working, construction and applications of steam boilers. |
| CO4 | Describe the working, construction and applications of Steam turbines. |
| CO5 | Describe the working, construction and applications of Steam Condensers. |
| CO6 | Describe different modes of heat transfer and different heat exchangers. |

**IV. Course Content Details:**

| Unit No. | Theory Learning Outcomes (TLO's) aligned to CO's. | Topics / Sub-topics |
|---|---|---|
| 1 | 1.1 Draw the thermodynamic properties (processes) on thermodynamic planes.<br>1.2 Explain the laws of thermodynamics.<br>1.3 Determine the rate of work done and thermal energy transfer during thermodynamic process in the given type of open system.<br>1.4 Explain non property (heat and work) of system. | **Unit-1: Fundamentals of Thermodynamics**<br>1.1 Basic Concepts Concept of pure substance, types of systems, properties of systems, Extensive and Intensive properties, processes, flow and non-flow specific temperature, density, Processes and cycles. volume, pressure.<br>1.2 Energy Work, Heat Transfer and Energy Thermodynamic definition of work and heat, difference between heat and work. energy -Potential Energy, kinetic Energy, internal Energy, Flow Work, concepts of enthalpy and physical concept of entropy.<br>1.3. Laws of Thermodynamics- first law of thermodynamics, second law of thermodynamics, Kelvin Planks, Clausius statements. Reversible and irreversible processes, concept of Entropy, factors making process irreversible, reversible Carnot cycle for heat engine and refrigerator.<br>1.4. Application of Laws of Thermodynamics- Steady flow energy equation and its application to boilers, engine, nozzle, turbine, compressor and condenser. Application of second law of thermodynamics to heat engine, heat pump and refrigerator (simple numericals). |
| **Course Outcome : CO1** | **Learning Hours : 10** | **Marks: 12** |
| 2 | 2.1 Evaluate the work done and thermal energy transfer according to gas laws for the given situation<br>2.2 Draw different thermodynamic processes on thermodynamic planes. (P-V, T-S etc.)<br>2.3. Determine characteristic gas constant of commonly used gases for the given data. | **Unit-2: Ideal Gases and Ideal Gas Processes**<br>2.1Avogadro's law, calculate molar volume. Derivation of characteristic gas equation using Boyle's and Charle's law, characteristic gas constant and universal gas constant<br>2.2 Ideal gas processes Isobaric, Isochoric, Isothermal, Isentropic, Polytropic, Throttling and their representation on P-V and T-S diagrams. Determination of work, heat, internal energy, enthalpy change and entropy change. |
| **Course Outcome : CO2** | **Learning Hours : 06** | **Marks: 08** |
| 3 | 3.1 Calculate dryness fraction for the given steam sample.<br>3.2 Represent different vapor processes on suitable coordinates in the given situation.<br>3.3 Identify types of boilers.<br>3.4 Identify different boiler mountings and accessories. | **Unit-3: Steam and steam boiler**<br>3.1 Steam fundamentals, Applications of steam, generation of steam at constant pressure with representation on various charts such as PV, TS, H-S. Properties of steam and use of steam table, dryness fraction, degree of superheat, sensible and latent heat, boiler efficiency, Mollier chart.<br>3.2 Vapour processes Constant pressure, constant volume, constant enthalpy constant entropy process (numerical using steam table to determine dryness fraction and enthalpy), Rankine cycle.<br>3.3 Steam Boilers Classification, Construction and working of |

| | | |
|---|---|---|
| | | different types of boilers. Boiler Draught, Indian Boiler Regulation (IBR)<br>3.4 Boiler mountings and accessories.<br>3.5 Basic layout of steam power plant. |
| Course Outcome : CO3 | Learning Hours : 08 | Marks: 12 |
| 4 | 4.1 Identify type of nozzles.<br>4.2 Understand working of turbines.<br>4.3 Understand the importance of wet steam, dry steam and superheated steam.<br>4.4 Understand importance of waste heat recovery. | **Unit-4: Steam turbines**<br>4.1 Steam nozzle Continuity equation, types of nozzles, concept of Mach number, critical pressure and choked flow condition, application of steam nozzles.<br>4.2 Steam turbine Classification of turbines, Construction and working of impulse and reaction turbine.<br>4.3 Compounding of turbines and its types, Regenerative feed heating, bleeding of steam, governing and its types, losses in steam turbines.<br>4.4 Waste heat recovery. |
| Course Outcome : CO4 | Learning Hours : 08 | Marks: 08 |
| 5 | 5.1 Identify the elements and processes of the given type of steam condensers<br>5.2 Identify the elements and processes of the given cooling towers.<br>5.3 Select condensers for the given situation.<br>5.4 Select cooling tower for the given situation. | **Unit-5: Steam Condensers**<br>5.1 Steam condensers: Dalton's law of partial pressure, classification of function and condensers, construction and working of surface condenser and jet condenser.<br>5.2 Condenser performance Sources of air leakage and its effect, concept of condenser efficiency, vacuum efficiency.<br>5.3 Cooling Towers-Construction and working of forced, natural and induced draught cooling tower. |
| Course Outcome : CO5 | Learning Hours : 06 | Marks: 08 |
| 6 | 6.1 Calculate heat transfer through conduction, convection and radiation.<br>6.2 Explain construction and working of a given type of heat exchangers with sketches.<br>6.3 Select heat exchangers for the given situation with justification. | **Unit-6: Heat transfer and heat exchangers**<br>6.1 Modes of heat transfer - Conduction, convection and radiation.<br>6.2 Conduction Fourier's law, thermal conductivity, conduction through cylinders, thermal resistance, composite walls, list of conducting and insulating materials.<br>6.3 Convection Newton's law of cooling. natural convection and forced.<br>6.4 Radiation- Thermal Radiation, absorptivity. transmissivity. reflectivity, emissivity, black and gray bodies, Stefan Boltzmann law.<br>6.5 Heat Exchangers: Classification, construction and working of shell and tube, shell and coil, and plate type heat exchanges, compact heat exchanger. LMTD and NTU approach, introduction to TEMA. |
| Course Outcome : CO6 | Learning Hours : 07 | Marks: 12 |

## V. 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 |
|---|---|---|---|---|
| 1.1Understand basic concepts of thermodynamics.<br>1.2 Understand laws of thermodynamics. | 1 | Assignment on fundamental concepts of thermodynamics and Laws of Thermodynamics. | 02 | CO1 |
| 2.1Understand behavior of ideal gases and their processes. | 2 | Assignment on ideal gases and thermodynamic processes. | 02 | CO2 |
| 3.1 Identify different types of boilers.<br>3.2 Understand the working of boilers. | 3 | Demonstration of working of different types of boilers. Such as Nestler boiler, Cochran, La-mont and Loeffler, Lancashire boiler, Babcock & Wilcox Boiler. | 04 | CO3 |
| 4.1 Understand the working of boiler mountings. | 4 | Demonstration of boiler of mountings. | 04 | CO3 |
| 5.1 Understand the working of boiler accessories. | 5 | Demonstration of boiler accessories. | 02 | CO3 |
| 6.1 Understand the applications of boilers, boiler mountings, accessories, turbine , and condenser. | 6 | Visit to thermal power plant/sugar factory/ process industry that uses boiler. | 04 | CO3, CO4, CO5 |
| 7.1 Understand modes of heat transfer. | 7 | Demonstration of heat transfer through conduction, convection and radiation. | 04 | CO6 |
| 8.1 Calculate thermal conductivity of metallic rod. | 8 | Calculate thermal conductivity of metallic rod. | 04 | CO6 |
| 9.1 Classify and understand use of heat exchangers. | 9 | Identify different equipment in power engineering lab having heat exchangers and classify heat exchangers. Write construction and working of any 03 of above heat exchangers. | 04 | CO6 |
| | | Total | 30 | |

**VI. Suggested Specifications Table (Theory):**

| Unit No | Topic Title | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|
| | | R Level | U Level | A Level | Total Marks |
| 1 | Fundamentals of Thermodynamics | 4 | 4 | 4 | 12 |
| 2 | Ideal Gases and Ideal Gas Processes | 2 | 2 | 4 | 08 |
| 3 | Steam and steam boiler | 2 | 4 | 4 | 10 |
| 4 | Steam turbines | 4 | 2 | 06 | 10 |
| 5 | Steam Condensers | 2 | 4 | 06 | 10 |
| 6 | Heat transfer and heat exchangers | 2 | 4 | 4 | 10 |
| **Total** | | **16** | **16** | **28** | **60** |

**VII. Assessment Methodologies/Tools:**

Formative assessment (Assessment for Learning)

Each sheet/ self-learning assignment to be assessed on following rubrics (10 marks)

| Attendance | Technical Understanding & Interpretation of given experiment/assignment/model. | Presentation & completion | Total |
|---|---|---|---|
| 02 Marks | 04 Marks | 04 Marks | 10 Marks |

**Summative Assessment (Assessment of Learning)**

TH - Term End examination of 60 Marks

**VIII. References/ Books:**

| Sr. No. | Title | Author, Publisher, Edition and Year of publication | ISBN |
|---|---|---|---|
| 1 | Engineering Thermodynamics | PK Nag; Tata McGraw Hill,Delhi. | 0-07-026062-1 |
| 2 | Basic Engineering Thermodynamics | Roy Chaudhary; Tata McGraw Hill,Delhi. | 9780070965881 |
| 3 | Engineering Thermodynamics | CP Arora; Tata McGraw Hill,Delhi. | 0-07-462014-2 |

| | | | |
|---|---|---|---|
| 4 | Thermal Engineering | R.S. Khurmi,& J.K.Gupta<br>S. Chand Technical Publication | 9788121925730 |
| 5 | Thermal Engineering | P.L.Ballaney ,Khanna Publication | 978-8174090317 |
| 6 | A Course in Thermal Engineering | Domkundwar .S,<br>Kothandaraman C.<br>P. Domkundwar, Dhanpat Rai & sons. | 9788177000214 |
| 7 | Thermal Engineering | M.M.Rathore, Tata McGraw Hill. | 9780070681132 |
| 8 | Thermal Engineering | Rajput R.K, Firewall Media, New Delhi 2005 | 9788170088349 |
| 9 | Thermodynamics: An Engineering Approach | Yunus A Cengel; Michael A Boles, Tata McGraw Hill,Delhi. | 978-9339221652 |
| 10 | TEMA handbook | TEMA (Tubular Exchanger Manufacturers Association) | ------ |

**E-References:**

1. https://swayam.gov.in/
2. www.youtube.com
3. https://learnengineering.org/
4. https://nptel.ac.in/

**CO Vs PO and CO Vs PSO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 |
| **CO2** | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 |
| **CO3** | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 3 |
| **CO6** | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 3 |

**Industry Consultation Committee:**

| **Sr. No** | **Name** | **Designation** | **Institute/Organisation** |
|---|---|---|---|
| 1 | Prof. Celestino Ruivo | Professor | University of Algarve-Portugal. |
| 2 | Dr. Ram Deshmukh | Lecturer In Mechanical Engg | Cusrow Wadia Institute of Technology, Pune. |
| | Dr. Vishal D. Chaudhari | Lecturer In Mechanical Engg | Cusrow Wadia Institute of Technology, Pune. |
| 3 | Mr.Sanjay Yelge | Sr. Manager | Thyssenkruup Industries, Pimpri, Pune. |
| 4 | Dr.S.G.Taji | HOD (Mechanical ) | G.P.Mumbai |
| 5 | Mr. E.C.Dhembare | LME, | G.P.Mumbai |

Coordinator,
Curriculum Development,
Department of _____

Head of Department
Department of _____

I/C, Curriculum Development Cell

Principal

| **Programme : Diploma in Mechanical Engineering** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code: ME23108** | | | | | **Course Title: THEORY OF MACHINES** | | | | | | | | |
| **Compulsory / Optional: Compulsory** | | | | | | | | | | | | | |
| **Learning Scheme and Credits** | | | | | | **Assessment Scheme** | | | | | | | |
| **CL** | **TL** | **LL** | **SLH** | **NLH** | **Credits** | **FA-TH** | | **SA-TH (2:30 Hrs.)** | **FA-PR** | **SA** | | **SLA** | **Total** |
| | | | | | | **T1** | **T2** | | | **PR** | **OR** | | |
| 3 | -- | 2 | 1 | 6 | 3 | 20 | 20 | 60 | 25 | -- | -- | 25 | 150 |

**Total IKS Hrs. for course: 02 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, SLA- Self Learning Assessment

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

**Note:**

1. FA-TH represents Total of two class tests of 20 marks each conducted during the term.
2. FA-PR represents Term work of 25 Marks
3. SLA represents self-learning Assessment of 25 Marks
4. SA-TH represents the end term examination of 60 Marks

## I. Rationale

Mechanical Engineers often come across various machines in professional life. They should be able to identify and interpret the significance of various machine elements. A diploma engineer should possess a solid understanding of machine fundamentals and mechanisms to effectively maintain various machines. This course imparts the study of different machine elements like gear, cam-follower, follower, belt-pulley, flywheel, brake, dynamometer, clutch, etc. Detailed knowledge of these aspects with deep insight into the practical applications develops a professional confidence in them to become successful Engineers. This course is a prerequisite for courses like Machine Design, and solid modelling to understand the working of mechanisms/ machines.

## II. Industry / Employer Expected Outcome

To visualize and understand the working of different mechanisms of machines.

## III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course.

| | |
|---|---|
| CO1 | Identify various links in popular mechanisms |
| CO2 | Conduct kinematic analysis on the simple mechanisms. |
| CO3 | Understand the operations of flywheels, governors, and necessity of balancing. |

| | |
|---|---|
| CO4 | Interpret the motions of different cam and followers. |
| CO5 | Suggest appropriate belts, chains, and gear drives for different application. |
| CO6 | Understand working of dynamometers and determine power transmission in clutches/brakes. |

**Course Content Details:**

| Unit No. | Theory Learning Outcomes (TLO's) aligned to CO's. | Topics / Sub-topics |
|---|---|---|
| 1 | TLO 1.1 Identify various links in the given figure of the mechanism with justification.<br>TLO 1.2 Describe with sketches the constructional details of the given type of mechanism.<br>TLO 1.3 Select suitable mechanism for the given application with justification.<br>TLO 1.4 Select suitable material of the mechanism for the given application with justification. | **Unit-I Fundamentals of Kinematics and Mechanisms**<br>1.1. Definition of Kinematics, Dynamics, statics, Kinetics, Kinematics link, Kinematics pair and its types,<br>1.2. Constrained motion and its types, Kinematic chain and its types, machine and structure. Mechanism, Degree of freedom.<br>1.3. Inversions of Kinematic Chain: Four bar chain, Single slider Crank and Double Slider Crank Chain |
| | **Course Outcome : CO1** **Teaching Hours : 07** **Marks: 08** | |
| 2 | 2.1 Use analytical method (without derivation) to calculate velocity and acceleration of given links in the single slider crank mechanism.<br>2.2 Estimate velocity and acceleration of any link at any instant in the given mechanism.<br>2.3 Describe with dimensioned sketch of the given mechanism.<br>2.4 Describe with velocity diagram for a given mechanism using relative velocity method.<br>2.5 Describe the acceleration diagram for the given mechanism.<br>2.6 Explain with velocity and acceleration diagram for the given mechanism using Klein"s construction. | **Unit- II Kinematic Analysis of Plane Mechanism**<br>2.1. Concept of relative velocity and relative acceleration of a point on a link, angular acceleration, inter-relation between linear and angular velocity and acceleration. Drawing of velocity and acceleration diagram of simple Mechanism.<br>2.2. Determination of velocity and acceleration of point on link by relative method (Excluding Coriolis's component of acceleration).<br>**2.3.** Analytical method and Klein's construction to determine velocity and acceleration of different links of single slider crank mechanism. |
| | **Course Outcome : CO2** **Teaching Hours : 08** **Marks: 12** | |
| 3 | 3.1 Explain with the sketches the method of balancing a rotating mass as per the given conditions.<br>3.2 Estimate the balancing mass and position of plane analytically and | **Unit-III Flywheel , Governor and balancing**<br>3.1. **Flywheel:** Flywheel –Concept, function and application of flywheel with the help of turning moment diagram for single cylinder 4-Stroke I.C Engine (no numerical) Coefficient of fluctuation of energy, coefficient of fluctuation of speed and its |

| | | |
|---|---|---|
| | graphically in the in the given situation for the given data.<br>3.3 Explain with the sketches the turning moment diagram for the given single cylinder 4 – stroke I.C. Engine for the given date | significance.<br>3.2. **Governors**: Types, concept, function and application and Terminology of Governors. Comparison between Flywheel and Governor.<br>**3.3. Balancing:** Introduction Static Balancing, Dynamic Balancing. Concept of Balancing, balancing of single revolving mass, Graphical and numerical method for balancing several masses in the same plane. |
| | **Course Outcome : CO3** **Teaching Hours : 08** **Marks: 10** | |
| **4** | 4.1 Identify the type of motion of follower in the given situation with justification.<br>4.2 Describe with dimensioned sketch of the given cam and follower arrangement.<br>4.3 Describe with cam profile for the given motion of knife – edge and roller follower arrangement. | **Unit-IV: Cam and Followers**<br>4.1. Concept, definition and application of Cams and followers.<br>4.2. Classification of Cams and followers Different follower motions and their displacement diagrams like uniform velocity, SHM, uniform acceleration and Retardation.<br>4.3. Drawing of profile of radial cam with knife edge and roller follower with and without offset with reciprocating motion. |
| | **Course Outcome : CO4** **Teaching Hours : 08** **Marks: 10** | |
| **5** | 5.1 Calculate velocity ratio, belt tensions, slip and angle of contact in the given belt drive.<br>5.2 Estimate power transmitted and condition for maximum power transmitted in the given belt drive for given data.<br>5.3 Select suitable belt for the given application with justification.<br>5.4 Calculate train value and velocity ratio for the given simple, compound, reverted, and epicyclic gear train.<br>5.5 Select suitable gear for the given application with justification.<br>5.6 Select suitable drive for the given application with justification. | **Unit-V**: **Power Transmission**<br>5.1. Belt Drives- flat belt, V-belt & its applications, material for flat and V-belt. Selection of belts, angle of lap belt length Slip and creep. Determination of velocity ratio, of tight side and slack side tension, centrifugal tension and initial tension, condition for maximum power transmission (Simple numerical).<br>5.2. Chain Drives- Types of chains and sprockets, velocity ratio. Advantages & Disadvantages of chain drive over other drives, Selection of Chain & Sprocket wheels, methods of lubrication.<br>5.3. Gear Drives – Spur gear terminology, types of gear trains and Law of gearing. |
| | **Course Outcome : CO5** **Teaching Hours : 07** **Marks: 10** | |
| **6** | 6.1 Calculate power transmitted by bearings.<br>6.2 .Describe with sketches the needs function and applications of the given clutches.<br>6.3 Calculate braking force, braking torque and power for brakes<br>6.4 Describe with sketches and working of dynamometer | **Unit-VI: Friction Bearing & Clutches, Brakes and Dynamometer**<br>6.1. Definition of friction, its necessity, Laws of friction, Friction between dry surfaces, coefficient of friction. Pivot and collar friction, uniform pressure and uniform wear assumptions, power absorbed in flat, and conical pivot bearings. Study of single plate, multiple plate, cone and centrifugal clutch. Simple numerical on power transmitted by them.<br>6.2. Definition Classification and comparison between brakes and dynamometers. Construction and working of Block brake, |

| | | |
|---|---|---|
| | | Band brake, Combined block and band brake, Internality expanding shoe brake and disc brake. (Numerical to find braking force and braking torque and power for block, band and block and band brake).<br>6.3. Construction and working of Rope brake dynamometer, Hydraulic dynamometer and Belt type transmission dynamometer. |
| | **Course Outcome : CO6** | **Teaching Hours : 07** **Marks: 10** |

**IV. 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 Understand concept of mechanism and inversion.<br>LLO 1.2 Understand construction and working of various inversions. | 1 | Study working of mechanisms and their inversions. | 02 | CO1 |
| LLO 2.1 Draw the sketch of selected inversion.<br>LLO 2.2 Prepare the links as per the sketch and assemble the links. | 2 | Prepare any two models of mechanisms or inversions. | 04 | CO1 |
| LLO 3.1 To draw velocity and acceleration diagram of given mechanism.<br>LLO 3.2 Calculate velocity and acceleration from velocity and acceleration diagram of given mechanism | 3 | Determine and draw velocity and acceleration diagram using relative velocity method for any four problems. | 04 | CO2 |
| LLO 4.1 To draw Klein's Construction for Single slider mechanism. | 4 | Draw Klein's Construction for Single slider mechanism. | 04 | CO2 |
| LLO 5.1 To draw the force diagram.<br>LLO 5.2 To determine the balancing mass. | 5 | Determine analytically and graphically balancing of several masses rotating in a single plane (Minimum two problems). | 04 | CO3 |
| LLO 6.1 To draw displacement diagram and cam profile. | 6 | Draw two cam profiles each on drawing sheets for the problems having without offset and with offset. | 08 | CO4 |
| LLO 7.1 Determine velocity ratio, belt tensions, slip and angle of contact in the given belt drive. | 7 | Calculate velocity ratio, belt tensions, slip and angle of contact in the given belt drive.( Any 5 numericals) | 02 | CO5 |
| LLO 8.1 Determine power transmitted by bearings and braking force, braking torque and power for brakes. | 8 | Calculate power transmitted by bearings and braking force, braking torque and power for brakes .( Any 5 numericals) | 04 | CO6 |
| **Total** | | | | **30** |

**Note:** All Experiments and Sheets are compulsory.

**Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):**

1. Compile information from internet related to various mechanisms /elements like Piston, crank, connecting rod, cam, clutch, brake, flywheel, governor and animation of mechanism along with functions and areas of applications of each.
2. List the mechanisms which you are using in your day to day life sketch any three from these.
3. List the different mechanisms used in a typical car.
4. Identify and measure the dimensions of flywheel used in automobile engines, generators, punching and riveting machines.
5. Identify different clutches used in different automobiles and also the type of brakes in automobile and bicycle.
6. Visit the market and collect the data of items which are used in any mechanisms. Data includes specifications, cost, and applications. Also names the mechanism/s in which such item/s is/are used.

## V. Specification Table:

| Unit No | Topic Title | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|
| | | R Level | U Level | A Level | Total Marks |
| 1 | **Fundamentals of Kinematics and Mechanisms** | 4 | 4 | 0 | 08 |
| 2 | **Kinematic Analysis of Plane Mechanism** | 2 | 4 | 6 | 12 |
| 3 | **Flywheel , Governor and balancing** | 2 | 4 | 4 | 10 |
| 4 | **Cam and Followers** | 4 | 0 | 6 | 10 |
| 5 | **Power Transmission** | 4 | 0 | 6 | 10 |
| 6 | **Friction Bearing & Clutches, Brakes and Dynamometer** | 2 | 4 | 4 | 10 |
| | **Total** | | | | 60 |

## VI. Assessment Methodologies/Tools

**Formative assessment (Assessment for Learning)**

Each sheet/ self-learning assignment to be assessed on following rubrics (10 marks)

| Attendance | Technical Understanding & Interpretation of given problem | Presentation & completion | Total |
|---|---|---|---|
| 02 Marks | 04 Marks | 04 Marks | 10 Marks |

**Summative Assessment (Assessment of Learning)**

- **TH -** Term End examination of 60 Marks

## VII. 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 |
| CO1 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| CO2 | 2 | 2 | 3 | 3 | 2 | 2 | 3 | 3 | 2 |
| CO3 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| CO4 | 2 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | 2 |
| CO5 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| CO6 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 |
| Legends: - High:03, Medium:02, Low:01, No Mapping: -- | | | | | | | | | |

## VIII. Suggested Learning Materials / Books

| Sr.No | Author | Title | Publisher |
|---|---|---|---|
| 01 | Theory of Machines | Rattan S.S. | McGraw-Hill Education, 1986 ISBN:9780070591202 |
| 02 | Theory of Machines | Khurmi R.S. Gupta J.K. | S. Chand Publications, New Delhi, 2012 ISBN: 9788131729656 |
| 03 | Theory of Machines | Bevan Thomas | Pearson Education India, New Delhi. 1986. ISBN: 97881317229656 |
| 04 | Theory of Machines& Mechanisms | Ballaney P.L. | Khanna Publisher. New Delhi, 2003 ISBN: 9788170084181 |
| 05 | A Text Book Of Theory of machines | Bansal R.K. Brar J.S. | Laxmi Publication, New Delhi, 2004, ISBN: 9788170084181 |

## IX. Learning Websites & Portals

| Sr .No | Link /Portal | Description |
|---|---|---|
| 1 | https://nptel.ac.in/ | Student can go through free course material for theory of machines |
| 2 | https://www.slideshare.net/ahirehemant/theory-of-machine | Student can go through free ppt for theory of machines |

| | | |
|---|---|---|
| 3 | https://www.youtube.com/watch?v=jzNik6PEKG8 | Student can go through free animation videos for theory of machines |
| 4 | https://www.youtube.com/watch?v=MJeRFzs4oRU | Student can go through free animation videos for theory of machines |

## X. Academic Consultation Committee/Industry Consultation Committee:

| Sr. No | Name | Designation | Institute/Organization |
|---|---|---|---|
| 1 | Mrs. Reshmi Ram | Director | RA Global solutions, Malad |
| 2 | Dr. V. P. Rathod | Sel. Grade Lecturer in Mechanical Engineering | Government Polytechnic, Thane |
| 3 | Dr. V. U. Rathod | Sel. Grade Lecturer in Mechanical Engineering | Government Polytechnic Mumbai |
| 4 | Mrs. A. N. Naik | Lecturer in Mechanical Engineering | Government Polytechnic Mumbai |

Coordinator,
Curriculum Development,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal

| **Programme : Diploma in Mechanical Engineering (Sandwich Pattern)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code: ME23109** | | | | | | **Course Title: Mechanical Engineering Drawing & Computer Aided Drafting (CAD)** | | | | | | | |
| **Compulsory / Optional: Compulsory** | | | | | | | | | | | | | |
| **Teaching Scheme and Credits** | | | | | | **Examination Scheme** | | | | | | | |
| **CL** | **TL** | **LL** | **SLH** | **NLH** | **Credits** | **FA-TH** | | **SA-TH (2 Hrs 30 min.)** | **FA- PR** | **SA** | | **SLA** | **Total** |
| | | | | | | **T1** | **T2** | | | **PR** | **OR** | | |
| – | -- | 4 | 2 | 6 | 3 | – | – | – | 25 | 50@ | -- | 25 | 100 |

**Total IKS Hrs. for course: 01 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, SLA- Self Learning Assessment
**Legends:** @ Internal Assessment, # External Assessment, *# Online Examination, @$ Internal Online Examination
**Note:**
1. FA-PR represents Term work of 25 Marks
2. SA-PR represents Summative assessment of 50 Marks
3. SLA represents self-learning Assessment of 25 Marks

## I. Rationale

A Mechanical Engineer, is expected to possess a thorough understanding of drawing, which includes clear visualization of objects and the proficiency in reading and interpreting a wide variety of production drawings. Besides, they are also expected to possess a certain degree of drafting skills depending upon job function, to perform day to day activity i.e. communicating and discussing ideas with supervisors and passing on instructions to subordinates unambiguously.

In the engineering world, CAD revolutionized modern day engineering and is widely used to design and develop products to be used by consumers. CAD allows for the easier development of products and product management integration. CAD drawings offer the flexibility to draft and design in a digital sphere, which were previously done by hand. The digital format makes data handling easier, safer, and quicker. Prior hand drawn blueprints can be scanned and then can be expanded upon digitally. Many CAD programs are now using three- dimensional drawings to maximize productivity and provide quicker, better product results, allowing for the development of the tiniest details. CAD's excellent ability for comprehensive documentation and communication allows for an easier product lifecycle management environment.

## II. Industry / Employer Expected Outcome

To imagine, understand, develop and prepare production drawings of different machine parts on drawing sheets. Also draw it digitally using Computer Aided Drafting software.

**III. Course Outcomes:** Students will be able to achieve & demonstrate the following COs on completion of course based learning.

| | |
|---|---|
| CO1 | Apply appropriate limits, fits, tolerances & surface finish on drawing. |
| CO2 | Use standard conventions of mechanical elements as per SP-46(1988). |
| CO3 | Use file management techniques in CAD software. |
| CO4 | Draw and modify simple 2D and 3D objects using CAD software. |
| CO5 | Draw production drawings of components/parts for a given assembly. |

**Course Content Details:**

| Unit No. | Laboratory Learning Outcomes (LLO's) aligned to CO's. | Topics / Sub-topics |
|---|---|---|
| 1 | 1.1 Calculate tolerances on the given machine components.<br>1.2 Identify fit required between mating parts of machine components based on the given tolerance values.<br>1.3 Interpret surface roughness characteristics from the values given on component drawing.<br>1.4 Draw above conventional representations for the given situation. | **Unit-I Limits, Fits and Tolerances**<br>1.1 Introduction to ISO system of tolerancing, dimensional tolerances, elements of interchangeable system, hole & shaft basis system, limits, fits & allowances. Selection of fit. (Simple Numerical)<br>1.2 Geometrical tolerances, tolerances of form and position and its geometric representation.<br>1.3 Characteristics of surface roughness - Indication of machining symbol showing direction of lay, roughness grades, machining allowances, manufacturing methods. |
| | **Course Outcome : CO1** **Practical Hours : 10** | |

| | | |
|---|---|---|
| **2** | 2.1 Use IS SP-46 (1988) codes.<br>2.2 Interpret standard conventions used in the given Mechanical working Drawing.<br>2.3 Use standard conventions in practice.<br>2.4 Interpret welding symbols in the given working drawing. | **Unit- II Production Drawing Basics**<br>2.1 Conventional Representations using SP – 46 (1988)<br>2.1.1 Materials C.I., M.S, Brass, Bronze, Aluminum, wood, Glass, Concrete and Rubber<br>2.1.2 Long and short break in pipe, rod and shaft.<br>2.1.3 Ball and Roller bearing, pipe joints, cocks, valves, internal / external threads.<br>2.1.4 Various sections- Half, removed, revolved, offset, partial and aligned sections.<br>2.1.5 Knurling, serrated shafts, splined shafts, and chain wheels.<br>2.1.6 Springs with square and flat ends, Gears, sprocket wheel<br>2.1.7 Countersunk & counter bore.<br>2.1.8 Tapers<br>2.2 Welded Joints: Representation of the following weld & preparing working drawing showing the size of weld, weld length, flush finish etc. Fillet<br>2.2.1 Square butt<br>2.2.2 Single and double U<br>2.2.3 Single and double V<br>2.2.4 Single and double J<br>2.2.5 Bevel butt<br>2.2.6 Edge / seam / bead<br>2.2.7 Spot weld<br>2.2.8 All round weld<br>2.2.9 Flush finish weld |
| | **Course Outcome : CO2** | **Practical Hours : 12** |
| **3** | 3.1 Explain use of computers in drafting and designing.<br>3.2 Use the AutoCAD workspace and interface.<br>3.3 Work with the User Coordinate System and World Coordinate System.<br>3.4 Apply different object selection methods in a given situation<br>3.5 Open, save and close new and given drawings/ templates | **Unit-III Introduction to Computer Aided Drafting:**<br>3.1 Various Software's for Computer Aided Drafting.<br>3.2 CAD initial settings commands.<br>3.3 Object Selection methods |
| | **Course Outcome : CO3** | **Practical Hours : 08** |

| | | |
|---|---|---|
| **4** | 4.1 Draw simple 2D entities using given draw commands.<br>4.2 Determine coordinates, distance, area, length. centroid of the given 2D entity.<br>4.3 Create a given complex 2D entity using modify commands.<br>4.4 Dimension given 2D entities using different dimensioning styles.<br>4.5 Apply Geometric and dimension tolerance symbols on the given entity.<br>4.6 Write text on a given 2D entity.<br>4.7 Create user defined dimension and text styles for a given situation<br>4.8 Plot given 2D entities using proper plotting parameters. | **Unit-IV: Basic Commands in CAD**<br>4.1 Zoom and formatting Commands:<br>4.1.1 Zoom Commands – all, previous, out, in, extent, realtime, dynamic, window, pan.<br>4.1.2 Formatting commands - Layers, block, linetype, lineweight, color.<br>4.2 Draw and Enquiry commands:<br>4.2.1 Draw Command - Line, arc, circle, rectangle, polygon, ellipse, point, spline, block, hatch etc.<br>4.2.2 Enquiry commands - distance, area, volume, and list command.<br>4.3 Edit and Modify commands:<br>4.3.1 Modify Command - Erase, break, trim, copy, move, mirror, offset, fillet, chamfer, array, extend, rotate, scale, lengthen, stretch, measure, divide, explode, align, join, spline edit Commands.<br>4.4 Dimensioning, Text and Plot Commands:<br>4.4.1 Dimensioning commands - Dimension styles, Dimensional Tolerances and Geometrical Tolerances, ddedit.<br>4.4.2 Text commands – Text style, dtext, mtext command.<br>4.4.3 Plotting & Publishing a drawing – creating standard template, title block, creating table, Bill plot Commands.<br>4.5 Drawing the given Sketches & Production Drawing of machine components. |
| | **Course Outcome : CO4** | **Practical Hours : 16** |
| **5** | 5.1 Explain the general procedure for assembly of components.<br>5.2 State details of components and the sequence of components of the given assembly.<br>5.3. Draw assembly drawing from the given detailed drawing.<br>5.4. Identify various components in the given assembly and the sequence of dismantling it.<br>5.5.Describe the procedure for dismantling the assembly into components.<br>5.6.Draw detailed drawing from the given assembly drawing. | **Unit-V**: **Assembly and Detailed drawing**<br>5.1 Assembly to Details: Introduction – basic principles of dismantling process. Preparation of detailed working drawing from given assembly, indicating proper type of fit & tolerance relevant to that fit and the grade of surface finish required. The drawing to be self-explanatory for manufacturing of the components.<br>The objects may be selected from the following & not containing more than 8 parts:<br>5.1.1 Lathe Tailstock<br>5.1.2 Jigs & Fixtures<br>5.1.3 Piston & connecting rod assembly<br>5.1.4 Gland and Stuffing box Assembly<br>5.1.5 Valves: Steam Stop Valve & Non – Return Valve<br>5.1.6 Fast & loose pulley<br>5.2 Details to Assembly: Preparation of the assembly drawings from the given detailed drawings of the parts of the machine unit. Objects may be selected from the following & not containing more than 8 parts.<br>5.2.1 Couplings – Universal couplings & Oldham's Coupling |

| | | |
|---|---|---|
| | | 5.2.2 Bearing – Foot Step Bearing & Pedestal Bearing<br>5.2.3 Lathe tool Post, Tail stock<br>5.2.4 Machine vice & Pipe Vice<br>5.2.5 Screw Jack<br>5.2.6 Jigs and Fixtures<br>5.2.7 Valves: Steam stop valves & Non Return Valves. |
| | **Course Outcome : CO5** | **Practical Hours : 14** |

## IV. 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 |
|---|---|---|---|---|
| | | **Machine Drawing** | | |
| **LLO 1.1** State details of different components of universal coupling<br>**LLO 1.2** Identify the sequence of components of its assembly. | 1 | Draw assembly and detailed drawing of Universal Coupling on the drawing sheet.<br><br>(Sheet No.01) | 08 | CO1, CO2, CO5 |
| **LLO 2.1** State details of different components of Foot Step Bearing<br>**LLO 2.2** Identify the sequence of components of its assembly. | 2 | Draw assembly and detailed drawing of Foot Step Bearing on the drawing sheet.<br><br>(Sheet No.02) | 08 | CO1, CO2, CO5 |
| **LLO 3.1** State details of different components of Oldham's Coupling<br>**LLO 3.2** Identify the sequence of components of its assembly. | 3 | Draw assembly and detailed drawing of Oldham's Coupling on the drawing sheet.<br><br>(Sheet No.03) | 08 | CO1, CO2, CO5 |
| | | **Computer Aided Drafting** | | |
| **LLO 4.1** Use the AutoCAD workspace and interface.<br>**LLO 4.2** Create,open, save and close new and given drawings/ templates<br>**LLO 4.3** Use a created template and draw simple geometric figures in it.<br>**LLO 4.4** Plot/print created drawing using proper plotting/printing parameters. | 4 | Prepare a template for our institute of A4 size with a title block.<br><br>Draw simple geometric figures (minimum 04 objects) using CAD software in the above template and take its print. | 06 | CO3, CO4 |

| | | | | |
|---|---|---|---|---|
| **LLO 5.1** Draw orthographic views using draw and modify commands.<br>**LLO 5.2** Dimension orthographic views using different dimensioning styles<br>**LLO 5.3** Plot/print created drawing using proper plotting/printing parameters. | 5 | Draw orthographic projections of any two objects using CAD software and take its print using a template. | 06 | CO3, CO4 |
| **LLO 6.1** Draw sectional orthographic views using draw and modify commands.<br>**LLO 6.2** Dimension/Hatch orthographic views using different dimensioning styles/hatching commands<br>**LLO 6.3** Plot/print created drawing using proper plotting/printing parameters. | 6 | Draw sectional orthographic projections of any two objects using CAD software and take its print using a template. | 06 | CO3, CO4 |
| **LLO 7.1** Draw isometric entities by doing required settings.<br>**LLO 7.2** Create isometric objects from given orthographic views.<br>**LLO 7.3** Plot/print created drawing using proper plotting/printing parameters. | 7 | Draw Isometric drawing in CAD software and take its print using a template.(Minimum 02 objects) | 04 | CO3, CO4 |
| **LLO 8.1** Draw simple 3D entities using 3D related commands.<br>**LLO 8.2** Plot/print created drawing using proper plotting/printing parameters. | 8 | Draw 3D drawings in CAD software and take its print using a template.(Minimum 04 objects) | 04 | CO3, CO4 |
| **LLO 9.1** Draw 2D production drawing of a given machine/machine component.<br>**LLO 9.2** Plot/print created drawing using proper plotting/printing parameters. | 9 | Draw assembly and detailed drawing of a given component using CAD software and take its print using a template(eg.Screw Jack) | 04 | CO3, CO4, CO5 |
| **LLO 10.1** Draw 2D production drawing of another machine/machine component.<br>**LLO 10.2** Plot/print created drawing using proper plotting/printing parameters. | 10 | Draw another assembly and detailed drawing of a given component using CAD software and take its print using a template.(e.g.Non Return Valve) | 06 | CO3, CO4, CO5 |

**Note:** All Sheets and Assignments are compulsory.

**Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):**

| Sr.No. | Title |
|---|---|
| 1 | **Assignment on Limit, Fit, Tolerances and Machining Symbols in sketch book.** |

| | |
|---|---|
| **2** | **Search any production drawing available on an internet website and write a report in a sketch book by explaining the meaning of various Fits, Tolerances and Machining Symbols shown in the drawing.** |
| **3** | **Assignment on Conventional Representation as per SP – 46 (1988) in sketchbook** |
| **4** | **Assignment on welded joints in sketch book.** |
| **5** | **Prepare a 3D model of any one the following machine parts using cardboards/ waste materials/metal/non-metal etc.**<br>**a.Couplings – Universal couplings & Oldham's Coupling**<br>**b.Bearing – Foot Step Bearing & Pedestal Bearing**<br>**c.Lathe tool Post, Tail stock**<br>**d. Machine vice & Pipe Vice**<br>**e.Screw Jack**<br>**f.Jigs and Fixtures**<br>**g.Valves: Steam stop valves & Non Return Valves.** |

**V. Specification Table:** Not Applicable

**VI. Assessment Methodologies/Tools:**

**Formative assessment (Assessment for Learning)**

Each sheet/ self-learning assignment to be assessed on following rubrics (10 marks)

| Attendance & Regularity | Technical Understanding & Interpretation of given problem | Line work, Accuracy, Presentation | Total |
|---|---|---|---|
| 02 Marks | 04 Marks | 04 Marks | 10 Marks |

**Summative Assessment (Assessment of Learning)**

- **Practical Examination: -** 50 Marks internal practical examination on drawing sheet based on curriculum.

**VII. 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** |
| CO1 | 03 | 02 | 02 | 03 | – | 02 | 03 | 03 | 01 |
| CO2 | 03 | 02 | 02 | 03 | – | 02 | 03 | 03 | 01 |
| CO3 | 03 | – | – | 01 | – | – | 03 | 01 | 01 |
| CO4 | 03 | – | 01 | 03 | – | 02 | 03 | 03 | 01 |
| CO5 | 03 | 01 | 03 | 03 | – | 02 | 03 | 03 | 01 |
| Legends: - High:03, Medium:02, Low:01, No Mapping: -- | | | | | | | | | |

**VIII. Suggested Learning Materials / Books**

| Sr.No | Author | Title | Publisher |
|---|---|---|---|
| 1 | Machine Drawing | N. D. Bhatt, Charotar Publishing House, 50th edition, 2016 | 978-9385-0392-32 |
| 2 | Production Drawing | L. K. Narayanan, P. Kannaich, K. Venkat Reddy, New Age International Publication, 3rd edition, 2006 | 978-8122-4251-85 |
| 3 | Machine Drawing | N Sidheswar, P Kannaiah &V V S Sastry, Tata McGraw Hill Education Pvt. Ltd., 2010 | 978-0074-6033-76 |
| 4 | Machine Drawing | N. D.Junnarkar, Pearson, 2006. | 978-8131-7067-87 |

| | | | |
|---|---|---|---|
| 5 | IS Code SP 46 (2003) | Code of practice for general engineering drawing, Engineering Drawing Practice for School and colleges, Bureau of Indian Standards, 9 Bahadur Shah Zafar Marg, New Delhi-110002 | 81-7061-019-2 |
| 6 | AutoCAD: A Problem-Solving Approach | Sham Tickoo, Delmar Cengage Learning (31 January 1998) | 978-0766-8012-95 |
| 7 | Machine Drawing with AutoCAD | Gautam Purohit & Gautam Ghosh, Pearson Publication | 978-1299-4461-82 |
| 8 | Mastering AutoCAD and AutoCAD LT 2018 | George Omura, BPB Publication | 978-1119-3867-97 |

## IX. Learning Websites & Portals

| Sr .No | Link /Portal | Description |
|---|---|---|
| 1 | http://www.we-r-here.com/cad/tutorials/index.htm | Student can go through free tutorials available related to CAD software |
| 2 | http://www.cadtutor.net/tutorials/autocad/ | Student can go through free tutorials available related to CAD software |
| 3 | http://www.caddprimer.com/AutoCAD_training_tutorial/AutoCAD_training_lessons.htm | Student can go through free tutorials available related to CAD software |
| 4 | http://www.autocadmark.com/ | Student can go through free tutorials available related to file conversion and CAD software |
| 5 | https://youtu.be/RGr2vzch-SI?si=2M1dnZdX7CPGFMIk | Assembly drawing |
| 6 | EKHO Institute presents Professional AutoCAD Training Videos | Complete CAD software tutorial for beginners |

**X. Academic Consultation Committee/Industry Consultation Committee:**

| Sr. No | Name | Designation | Institute/Organization |
|---|---|---|---|
| 1 | Mr.D.G.Pendokhare | Lecturer in Mechanical Engineering | Government Polytechnic, Thane |
| 2 | Mr.Gopal Patil | Senior Lead Engineer | Stellantis India Ltd Pune. |
| 3 | Mr. K. V. Patil | Sel. Grade Lecturer in Mechanical Engineering | Government Polytechnic, Mumbai |
| 4 | Mr. E. C. Dhembare | Lecturer in Mechanical Engineering | Government Polytechnic, Mumbai |

Coordinator,
Curriculum Development,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal

| **Programme: Diploma in Mechanical Engineering (Sandwich Pattern)** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code: ME23110** | | | | | **Course Title: Fluid Mechanics and Machinery** | | | | | | | | |
| **Compulsory / Optional: Compulsory** | | | | | | | | | | | | | |
| **Teaching Scheme and Credits** | | | | | | **Examination Scheme** | | | | | | | |
| **CL** | **TL** | **LL** | **SLH** | **NLH** | **Credits** | **FA-TH** | | **SA-TH** | **FA-PR** | **SA** | | **SLA** | **Total** |
| | | | | | | **T1** | **T2** | | | **PR** | **OR** | | |
| 4 | - | 2 | - | 6 | 3 | 20 | 20 | 60 | 25 | 25# | - | - | 150 |

**Total IKS hrs. for course: 2**

**Abbreviations:** CL- Class Room Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment

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

**Note:**

1. FA-TH represents total TWO class tests of 20 marks each conducted during the term.
2. SA-TH represents End term exam of 60 marks.
3. FA-PR represents Term work of 25 marks.
4. SLA represents self-learning assessment.

## I. Rationale

**Knowledge of fluid properties, fluid flow and fluid machinery is essential in all fields of engineering. Hydraulic machines have important role in water supply, irrigation, power generation etc. This course is intended to develop the skills to estimate loss in pipes, efficiency of hydraulic machines like turbines, pump etc.,**

## II. Industry / Employer Expected Outcome

**Select a pump for a particular application. Diagnose and rectify the faults in pumps and turbines, replace the pressure gauges and other accessories on hydraulic machines and apply their knowledge in hydraulics to select appropriate devices like pressure gauge, valves, flow devices, pipes etc. for different field applications.**

**III. Course Outcomes:** Students will be able to achieve & demonstrate the following COs on completion of course-based learning-

| | |
|---|---|
| CO1 | Measure fluid pressure using manometers and gauges. |
| CO2 | Understand and use floe meters to measure velocity and discharge of fluid. |
| CO3 | Analyze flow and find out energy losses of fluid while troughing pipes. |
| CO4 | Analyze impact of jet on various types of vanes for optimum efficiency. |
| CO5 | Understand performance of hydraulic turbine |
| CO6 | Understand performance of hydraulic pump |

**IV.Course Content Details:**

| Unit No. | Theory Learning Outcomes (TLO's) aligned to CO's. | Topics / Sub-topics |
|---|---|---|
| 1 | 1.1 Understand various properties and their correlations.<br>1.2 Understand various aspects of pressure along with their correlations.<br>1.3 Learn to measure/ calculate the pressure using devices. | **Properties of Fluid and Fluid Pressure**<br>**1.1.** Properties of Fluid: Density, Specific Gravity, Specific volume, Viscosity, Surface tension, Capillarity, Vapor pressure, Compressibility.<br>**1.2.** Fluid Pressure: Fluid pressure, Pressure head, Pressure intensity, Concept of absolute vacuum, Gauge pressure, Atmospheric pressure, Absolute pressure,<br>**1.3.** Pressure Measurement: Simple and differential manometers, Bourdon's tube pressure gauge. Total pressure, Center of pressure (Horizontal, Vertical, Inclined surfaces).<br>**Course Outcome-CO1 Teaching Hours – 10 Marks –10** |
| 2 | 2.1 Understand different types of flows.<br>2.2 Understand Bernoulli's theorem & its applications.<br>2.3 Understand Venturimeter & Orifice meter.<br>2.4 Understand Pitot tube | **Fluid Flow**<br>**2.1.** Types of fluid flow: Laminar, Turbulent, Steady, Unsteady, Uniform, non-uniform, Rotational, Irrotational, One, Two, Three dimensional.<br>**2.2.** Continuity equation. Bernoulli's Theorem<br>**2.3.** Venturimeter – Construction, Principle of working, Coefficient of discharge.<br>**2.4.** Orifice meter - Construction, Principle of working, coefficients for orifice,<br>**2.5.** Pitot tube- Construction, Principle of working.<br>**Course Outcome-CO2 Teaching Hours – 10 Marks –10** |
| 3 | 3.1 Understand major losses.<br>3.2 Understand minor losses.<br>3.3 Understand power transmission through pipes.<br>3.4 Learn the concept of water hammer. | **Flows Through Pipes.**<br>**3.1.** Laws of fluid friction. Darcy's equation & Chezy's equation for loss of head.<br>**3.2.** Minor losses in pipe fittings and valves<br>**3.3.** Hydraulic power transmission through pipe.<br>**3.4.** Water hammer phenomenon in pipes, causes and remedial action<br>**Course Outcome: CO3 Teaching Hours: 08 Marks- 08** |

| Unit No. | Theory Learning Outcomes (TLO's) aligned to CO's. | Topics / Sub-topics |
|---|---|---|
| 4 | 4.1 Understand the impact of jet on a plate using different cases.<br>4.2 Understand the impact of jet on a moving plate using different cases. | **Impact of Jets**<br>**4.1.** Impact of jet on fixed vertical flat plates, inclined flat plates.<br>**4.2.** Impact of jet on Moving vertical flat plates, inclined flat plates.<br>**4.3.** Impact of jet on curved Vanes.<br>**Course Outcome: CO4 Teaching Hours: 08 Marks: 08** |
| | 5.1 Understand the hydroelectric power plant.<br>5.2 Learn the different hydro turbines.<br>5.3 Understand the need of draft tube.<br>5.4 Calculate the efficiency of turbine. | **Hydraulic Turbines**<br>**5.1.** Layout & features of hydroelectric power plant.<br>**5.2.** Classification of hydraulic turbines.<br>**5.3.** Construction & working principle of Pelton wheel Turbine, Francis Turbine, Kaplan Turbine.<br>**5.4.** Draft tubes- types and construction, Concept of cavitations in turbine<br>**5.5.** Calculation of work done & power efficiency of turbine.<br>**Course Outcome: CO5 Teaching Hours: 12 Marks: 12** |
| 6 | 6.1 Understand the various aspects of a centrifugal pump.<br>6.2 Understand the various aspects of a reciprocating pump. | **Hydraulic Pumps**<br>**6.1.** Centrifugal pumps: Construction, Principle of working, Methods of priming & Cavitation. Types of casing & impellers. Manometric head.<br>**6.2.** Reciprocating pumps: Construction, working principles & applications of single & double acting reciprocating pumps, Concept of slip, negative slip. Cavitation and separation. Use of air vessel. Criteria for pump selection<br>**Course Outcome: CO6 Teaching Hours: 12 Marks: 12** |

## V. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

| Sr No | Laboratory Learning Outcome **(LLO)** aligned to CO's. | **Laboratory Experiment / Practical Titles / Tutorial Titles** | **Number of hrs.** | **Relevant COs** |
|---|---|---|---|---|
| 1 | 1.1.Use pressure gauges and manometers to measure water pressure. | Use U tube manometer to measure water pressure and discharge of water. | 02 | CO1 |
| 2 | 2.2. Verify the theorem practically. | Verification of Bernoulli's theorem | 02 | CO2 |
| 3 | 2.3. To measures the discharge | Use Venturimeter to measure discharge through a pipe. | 02 | CO2 |
| 4 | 2.4 To find out the coefficient along with discharge | Determination of coefficient of discharge for flow through orifice | 02 | CO2 |

| Sr No | Laboratory Learning Outcome **(LLO)** aligned to CO's. | **Laboratory Experiment / Practical Titles / Tutorial Titles** | **Number of hrs.** | **Relevant COs** |
|---|---|---|---|---|
| 5 | 3.1.Apply knowledge to find out the friction in pipes. | Determine Darcy's friction factor 'f' in pipes of different diameters. | 02 | CO3 |
| 6 | 3.2 Apply knowledge to find out the losses in pipes. | Determine losses in sudden expansion, sudden contraction, bend and elbow in pipes | 02 | CO3 |
| 7 | 5.3 Use the knowledge and find out the efficiency. | Determine overall efficiency of Pelton Wheel | 02 | CO5 |
| 8 | 6.1 Learn to use centrifugal pump. | Study centrifugal pump | 02 | C06 |
| 9 | 6.2 Learn to use reciprocating pump. | Study reciprocating pump | 02 | CO6 |

**VI. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning): Nil.**

**VII. Specification Table:**

| Unit No | Topic Title | Distribution of Theory Marks | | | |
|---|---|---|---|---|---|
| | | **R Level** | **U Level** | **A Level** | **Total Marks** |
| 1 | Fluid pressure & its measurement | 06 | 04 | - | 10 |
| 2 | Fluid flow | 02 | 04 | 04 | 10 |
| 3 | Flows through pipes | - | 04 | 04 | 08 |
| 4 | Impact of jets | - | 04 | 04 | 08 |
| 5 | Hydraulic turbines | 04 | 08 | - | 12 |
| 6 | Hydraulic pump | 04 | 08 | - | 12 |
| | **Total** | **16** | **32** | **12** | **60** |

**VIII. Assessment Methodologies/Tools**

**Formative assessment (Assessment for Learning)**

Each experiment/ assignment to be assessed on following rubrics (10 marks)

| Attendance & Regularity | Technical Understanding & Interpretation of given problem | Line work, Accuracy, Presentation | Total |
|---|---|---|---|
| | | | |

| 02 Marks | 04 Marks | 04 Marks | 10 Marks |
|---|---|---|---|

**Summative Assessment (Assessment of Learning)**

End term practical examination of TWO hrs. (25 marks).

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 |
| CO1 | 03 | 03 | - | 03 | - | - | 01 | 03 | 03 |
| CO2 | 03 | 03 | - | 03 | - | - | 01 | 03 | 03 |
| CO3 | 03 | 03 | - | 03 | - | - | 01 | 03 | 03 |
| CO4 | 03 | 03 | - | 03 | - | - | 01 | 03 | 03 |
| CO5 | 03 | 03 | - | 03 | - | 01 | 02 | 03 | 03 |
| CO6 | 03 | 03 | | 03 | - | 01 | 02 | 03 | 03 |
| Legends: - High:03, Medium:02, Low:01, No Mapping: -- | | | | | | | | | |

## IX. Suggested Learning Materials / Books

| Sr. No. | Title | Author, Publisher, Edition and Year Of publication | ISBN |
|---|---|---|---|
| 1 | Hydraulics and Fluid Mechanics including Hydraulic Machines | Modi P. N. Seth S. M. Standard Book House New Delhi, 22nd Ed., 2013 | 978-8189-4012-69 |
| 2 | Fluid Mechanics and Hydraulic Machine | Bansal R. K. Laxmi Publication Pvt. Ltd. New Delhi, 22nd Ed., 2018 | 978-8131-8081-53 |
| 3 | A textbook of Fluid Mechanics and Hydraulic Machines | Rajput R. K. S Chand and Company Pvt. Ltd. New Delhi, 6th Ed., 2016 | 978-9385-4013-74 |
| 4 | Fluid Mechanics and Hydraulic Machines problems and solution | Subramanya K. Tata McGraw Hill Co Ltd New Delhi, 4th Ed., 2011 | 978-0070-6998-09 |
| 5 | Introduction to Fluid Mechanics and Fluid Machines | Som S. K. Biswas G Tata McGraw Hill Co Ltd New Delhi, 3rd Ed., 2005 | 978-0071-3291-94 |
| 6 | A textbook of Hydraulics, Fluid Mechanics and Hydraulic Machines | Khurmi R. S. S Chand and Company Pvt. Ltd. New Delhi, 9th Ed., 2015 | 978-8121-9016-28 |

| | | | |
|---|---|---|---|
| 7 | Hydraulics, Fluid Mechanics and Hydraulic Machines | Ramamrutham S. Dhanpat Rai and Sons New Delhi, 9th Ed., 2011 | 978-9384-3782-71 |
| 8 | Hydraulic Machines | Jagdish Lal Metropolitan 3rd Ed., 2008 | 978-8120-0042-21 |

## X. Learning Websites & Portals

| Sr.No | Link / Portal |
|---|---|
| 1 | **www.nptel.ac.in/courses** |
| 2 | **www.learnerstv.com** |
| 3 | **www.ni.com/multisim** |

## XI. Academic Consultation Committee/Industry Consultation Committee:

| Sr. No | Name | Designation | Institute/Organization |
|---|---|---|---|
| 1 | Mr. R.H. Ramteke | General Manager | Tinita Engineering Pvt Ltd, Dhahej |
| 2 | Mr. C. R. Khaire | Lecturer in Mechanical Engineering | K.J. S. P.,Vidyavihar, Mumbai |
| 3 | Mr. S. B. Bidgar | Lecturer in Mechanical Engineering | Government Polytechnic, Mumbai |
| 4 | Mr. K.Z.Dhangare | Lecturer in Mechanical Engineering | Government Polytechnic, Mumbai |

Coordinator,
Department of Mechanical Engineering

Head of Department
Department of Mechanical Engineering

I/C, Curriculum Development Cell

Principal

| **Programme : Diploma in ME** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Code: ME 23301** | | | | | **Course Title: ENVIRONMENTAL STUDIES** | | | | | | | |
| **Compulsory / Optional: Compulsory** | | | | | | | | | | | | |
| **Learning Scheme and Credits** | | | | | | **Assessment Scheme** | | | | | | |
| **CL** | **TL** | **LL** | **SLH** | **NLH** | **Credits** | **FA-TH** | **SA-TH (2 Hrs. 30Min.)** | **FA-PR** | **SA** | | **SLA** | **Total** |
| | | | | | | | | | **PR** | **OR** | | |
| **-** | **-** | **2** | | **2** | **1** | **-** | **-** | **25** | **-** | | | **25** |

**Total IKS Hrs. for course: 1**

**Abbreviations:** CL- Classroom Learning, TL- Tutorial Learning, LL- Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, SLA- Self Learning Assessment
**Legends:** @ Internal Assessment, # External Assessment, *# On Line Examination, @$ Internal Online Examination
**Note:**
1 FA-PR represents Term work of 25 Marks

## I. Rationale

Environmental studies is the interdisciplinary academic field which systematically studies human interaction with the environment in the interests of solving complex problems. It is a broad field of study that also includes the natural environment, built environment, and the sets of relationships between them. The turn of the twentieth century saw the gradual onset of its degradation through depletion of resources such as air, water and soil; the destruction of ecosystems and the extinction of wildlife by our callous deeds without any concern for the well-being of our surrounding. We are today facing a grave environmental crisis. It is therefore necessary to study environmental issues to realize how human activities affect the environment and what could possibly be the remedies or precautions which need to be taken to protect the environment.

## II. Industry / Employer Expected Outcome

To understand the significance of environment pollution and follow different government norms to protect the environment.

## III. Course Outcomes: Students will be able to achieve & demonstrate the following COs on completion of course based learning

| | |
|---|---|
| CO1 | Identify various terms related to the environment and its importance. |
| CO2 | Identify and distinguish Ecosystems and Biodiversity. |
| CO3 | Identify various types of Environmental Pollutions and specify its solutions. |
| CO4 | Identify various Environmental Issues and sustainable development goals. |
| CO5 | Identify measures taken by the Government of India to protect the environment. |

**Course Content Details:**

| Unit No. | Theory Learning Outcomes (TLO) | Topics / Sub-topics |
|---|---|---|
| 1 | **TLO1.1** Explain the Scope and Importance of the environmental studies<br>**TLO1.2** Explain the importance/significance of the environmental studies<br>**TLO 1.3** Describe the need for creating public awareness<br>**TLO 1.4** Describe the ways/means/methods of creating public awareness | **Introduction to Environmental Studies**<br><br>1.1 Definition, Scope and Importance of the environmental studies<br>1.2 Importance/significance of the environmental studies<br>1.3 Need for creating public awareness about environmental issues<br>1.4 Ways/means/methods of creating public awareness<br>1.5 Some important terms related with Environmental Studies<br><br>**Course Outcome : CO1 Practical Hours : 6 hrs** |
| 2 | **TLO2.1** Explain the concept of Ecosystem<br>**TLO2.2** Explain the classification of Ecosystem<br>**TLO2.3** Explain the basic structure and functions of ecosystem<br>**TLO2.4** Describe energy flow in ecosystem<br>**TLO2.5** State the definition of Biodiversity<br>**TLO2.6** Explain the levels of biodiversity<br>**TLO2.7** Explain the Threats to biodiversity<br>**TLO2.8** Explain the Conservation of biodiversity | **Ecosystems and Biodiversity**<br><br>2.1 Concept of Ecosystem<br>2.2 Classification<br>2.3 Structure and functions of ecosystem: Basics<br>2.4 Energy flow in ecosystem:Gross primary product and Net primary product, Autotrophic levels and Bioaccumulation<br>2.5 Definition of Biodiversity<br>2.6 Levels of biodiversity: Genetic, Species, Community & Ecosystem<br>2.7 Threats to biodiversity:Habitat destruction, Invasive species, Genetic pollution, Overexploitation, Hybridization, Climate change & Overpopulation<br>2.8 Conservation of biodiversity: In-situ & Ex-situ<br><br>**Course Outcome: CO2 Practical Hours : 6 hrs** |
| 3 | **TLO3.1** Explain the definition of environmental pollution<br>**TLO3.2** Understand and Explain the Air pollution<br>**TLO3.3** Understand and Explain the Water Pollution<br>**TLO3.4** Understand and Explain the Soil Pollution<br>**TLO3.5** Understand and Explain the Noise Pollution | **Environmental Pollution**<br><br>3.1 Definition of environmental pollution<br>3.2 Air pollution: Definition, sources, effects, prevention<br>3.3 Water Pollution: Definition, sources, effects, prevention<br>3.4 Soil Pollution: Definition, sources, effects, prevention<br>3.5 Noise Pollution: Definition, sources, effects, prevention<br><br>**Course Outcome:CO3 Practical Hours : 6 hrs** |
| 4 | **TLO4.1** Explain the development Goals<br>**TLO4.2** Explain the Water conservation methods.<br>**TLO4.3** Explain the Rain water harvesting | **Environmental Issues and Sustainable Development**<br><br>4.1 Concept of development and Seventeen Sustainable development Goals<br>4.2 Water conservation and its method<br>4.3 Rain water harvesting<br>4.4 Climate Change: Causes<br>4.5 Global warming, Acid rain, Ozone Layer Depletion, |

| | | |
|---|---|---|
| | **TLO4.4** Explain the Climate Change:<br>**TLO4.5** Explain the Nuclear Accidents and Holocaust<br>**TLO4.6** Explain the Concept of Carbon Credits and its advantages | 4.6 Nuclear Accidents and Holocaust<br>4.7 Concept of Carbon Credits and its advantages<br><br>**Course Outcome:CO4 Practical Hours : 6 hrs** |
| **5** | **TLO5.1** Understand various Environmental Acts<br>**TLO5.2** Explain the EIA Clearance procedure<br>**TLO5.3** Explain the Montreal protocol and ozone cell, Wetlands<br>**TLO5.4** Explain the Green Building and rating systems | **Environmental Protection**<br><br>5.1 Brief description of the following acts and their provisions:<br>• Environmental Protection Act, 1986<br>• Air (Prevention and Control of Pollution) Act, 1981<br>• Water (Prevention and Control of Pollution) Act, 1974<br>• Wildlife Protection Act 1972<br>• Forest Conservation Act, 1980 & 1988<br>5.2 EIA Clearance procedure<br>5.3 Montreal protocol and ozone cell, Wetlands, CDM approval, PARIVESH, Genetic Engineering Appraisal Committee (GEAC) Clearances, Hazardous Waste Import and Export Clearances<br>5.4 Introduction to Green Building and rating systems<br>5.5 Introduction to ISO 14001: 2015 Environmental management systems.<br><br>**Course Outcome:CO5 Practical Hours : 6 hrs** |

## IV. Laboratory Learning Outcome and Aligned Practical / Tutorial Experiences.

| Sr No | Laboratory Learning Outcomes (LLO) | Laboratory Experiment / Practical Titles / Tutorial Titles | Number of hrs. | Relevant COs |
|---|---|---|---|---|
| 1 | **LLO 1.1** Follow safety rules in environmental studies laboratory. | a) Definition, Scope and Importance of the environmental studies & Some important terms related with Environmental Studies<br>b) Importance/significance of the environmental studies. | 2 | CO1 |
| 2 | **LLO2.1** Identify the need for creating public awareness about environmental issues and to find Ways/means/ methods of creating public awareness | a) Need for creating public awareness about environmental issues<br>b) Ways/means/methods of creating public awareness | 2 | CO1 |
| 3 | **LLO 3.1** Determine the Concept of Ecosystem, Classification, Structure and functions of Ecosystem | a) Concept of Ecosystem, Classification, Structure and functions of ecosystem<br>b) Energy flow in ecosystem: Gross primary product and Net primary product, Autotrophic levels and Bioaccumulation | 4 | CO2 |

| | | | | |
|---|---|---|---|---|
| | **LLO 3.2** Identify the Energy flow in ecosystem | | | |
| 4 | **LLO 4.1** Explain Biodiversity and to study Levels of biodiversity, Threats to biodiversity<br>**LLO 4.2** Explain the Hybridization, Climate change & Overpopulation, Conservation of biodiversity | a) Definition of Biodiversity, Levels of biodiversity: Genetic, Species, Community & Ecosystem, Threats to biodiversity: Habitat destruction, Invasive species, Genetic pollution, Overexploitation,<br>b) Hybridization, Climate change & Overpopulation, Conservation of biodiversity: In-situ & Ex-situ | 4 | CO2 |
| 5 | **LLO 5.1** Explain environmental pollution<br>**LLO 5.2** Explain the types of environmental pollution | a) Definition of environmental pollution, Air pollution: Definition, sources, effects, prevention<br>b) Water Pollution: Definition, sources, effects, prevention | 4 | CO3 |
| 6 | **LLO 6.1** Explain the Soil Pollution<br>**LLO 6.2** Explain the Noise Pollution | a) Soil Pollution: Definition, sources, effects, prevention<br>b) Noise Pollution: Definition, sources, effects, prevention | 2 | CO3 |
| 7 | **LLO 7.1** Explain the Sustainable development Goals<br>**LLO 7.2** Explain the Rain water harvesting | a) Concept of development and Seventeen Sustainable development Goals, Water conservation and its method<br>b) Rain water harvesting, Climate Change: Causes | 4 | CO4 |
| 8 | **LLO 8.1** Describe the concept of Global warming, Acid rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust<br>**LLO 8.2** Describe the concept of Carbon Credits and its advantages | a) Global warming, Acid rain, Ozone Layer Depletion, Nuclear Accidents and Holocaust<br>b) Concept of Carbon Credits and its advantages | 4 | CO4 |
| 9 | **LLO 9.1** Describe various Environmental Acts | a) Brief description of the following acts and their provisions,<br>Environmental Protection Act, 1986,<br>Air (Prevention and Control of Pollution) Act, 1981<br>b) Water (Prevention and Control of Pollution) Act, 1974, Wildlife Protection Act 1972, Forest Conservation Act, 1980 &1988 | 2 | CO5 |
| 10 | **LLO 10.1** Explain the EIA Clearance procedure<br>**LLO 10.2** Explain the Montreal protocol and ozone cell, Wetlands, CDM | a) EIA Clearance procedure<br>b) Montreal protocol and ozone cell, Wetlands, CDM approval, PARIVESH, Genetic Engineering Appraisal Committee (GEAC) Clearances, Hazardous Waste Import and Export Clearances | 2 | CO5 |

| | | | | |
|---|---|---|---|---|
| | approval, PARIVESH, Genetic Engineering Appraisal Committee (GEAC) Clearances, Hazardous Waste Import and Export Clearances | | | |

**V. Suggested Micro Project / Assignment/ Activities for Specific Learning / Skills Development (Self Learning):**

**----**

**Formative assessment (Assessment for Learning)**

- **Rubrics for continuous assessment based on process and product related performance indicators (25 marks)**

Each assignment to be assessed on following rubrics (10 marks)

| Attendance | Understanding & Interpretation | Presentation and completion | Total |
|---|---|---|---|
| 02 Marks | 04 Marks | 04 Marks | 10 Marks |

**Summative Assessment (Assessment of Learning)**

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### a) 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 | 1 | -- | -- | 3 | -- | 2 | 2 | 1 | |
| CO2 | 2 | 2 | -- | -- | 3 | -- | 2 | 3 | 2 | |
| CO3 | 3 | 2 | 1 | 2 | 3 | 1 | 2 | 2 | 2 | |
| CO4 | 3 | 2 | -- | 1 | 3 | 1 | 2 | 2 | 2 | |
| CO5 | 2 | 2 | 1 | 1 | 3 | 1 | 2 | 3 | 3 | |
| Legends: - High:03, Medium:02, Low:01, No Mapping: -- | | | | | | | | | | |

### b) Suggested Learning Materials / Books

| Sr.No | Author | Title | Publisher |
|---|---|---|---|
| 01 | AninditaBasak | Environmental Studies | Pearson Education |
| 02 | R. Rajgopalan | Environmental Studies from Crisis to Cure | Oxford University Press |
| 03 | Dr. R. J. Ranjit Daniels, Dr. JagdishKrishnaswamy | Environmental Studies | Wiley India |

### c) Learning Websites & Portals

| Sr.No | Link / Portal | Description |
|---|---|---|
| 1 | https://moef.gov.in/ | For environmental Info |
| 2 | www.youtube.com/ | For Various subjects |
| 3 | http://www.quora.com | |
| 4 | http://www.nationallibrary.gov.in | |

**d) Academic Consultation Committee/Industry Consultation Committee:**

| Sr. No | Name | Designation | Institute/Organization |
|---|---|---|---|
| 1 | Shri. R. G. Tambat | Head of Civil engineering department | K.J.Somaiya Polytechnic, Vidyavihar |
| 2 | Shri. Sudhir Nimbalkar | Assistant Engineer | Brihanmumbai Municipal Corporation (BMC) |
| 3 | Mr. K.V. Patil | Sr. Lecturer in Mechanical Engg. | Govt. Polytechnic Mumbai |
| 4 | Dr V. U. Rathod | Sr. Lecturer in Mechanical Engg. | Govt. Polytechnic Mumbai |

| | |
|---|---|
| Coordinator, | Head of Department |
| Curriculum Development, | Department of _____ Engineering |
| Department of _____ Engineering | |
| I/C, Curriculum Development Cell | Principal |