| Title of the Course: ENGINEERING MATHEMATICS-III | L | T | P | Credits |
|---|---|---|---|---|
| Course Code: UMCH0301 | 3 | 1 | --- | 4 |

**Course Pre-Requisite: Basic terminologies of differential equations, vector algebra, concepts of probability, rules and formulae of integration.**

**Course Description: This Course contains linear differential equations, vector calculus, Laplace transform, probability distributions, Fourier series and applications of partial differential equations.**

**Course Objectives:**

1. To develop abstract, logical and critical thinking and the ability to reflect critically upon their work.
2. To study various mathematical tools like differential equations, integral transforms, vector calculus, probability and partial differential equations to devise engineering solutions for given situations.
3. The student must be able to formulate a mathematical model of a real life and engineering problem, solve and interpret the solution in real world.

**Course Outcomes:**

| COs | After the completion of the course the student will be able to | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| CO1 | **Solve** linear differential equations with constants coefficients and **apply** them to realistic problems. | III | |
| CO2 | **Find** directional derivatives and **apply** knowledge of vector differentiation to find curl and divergence of vector fields. | IV | |
| CO3 | **Evaluate** Laplace transforms of given functions and **use** it to solve LDEs. | III | |
| CO4 | **Determine** the defectiveness in items / products using probability distributions. | III | |
| CO5 | **Express** the given function as Fourier series over the given interval. | III | |
| CO6 | **Solve** the wave, heat equations analytically and Laplace equation numerically by Gauss – Siedel method | III | |

**CO-PO Mapping:**

| CO | a | b | c | d | e | f | g | h | i | j | k |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | | |
| CO2 | | | | | | | | | | | |
| CO3 | | | | | | | | | | | |
| CO4 | | | | | | | | | | | |
| CO4 | | | | | | | | | | | |
| CO5 | | | | | | | | | | | |
| CO6 | | | | | | | | | | | |

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three units)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three units) covered after MSE.

**Course Contents:**

| | |
|---|---|
| **Unit 1: Linear Differential Equations with Constant Coefficients and Its Applications**<br>1.1 Definition, general form, complete solution<br>1.2 Rules for finding complementary function<br>1.3 Rules for finding particular integral<br>1.4 Mass – spring Mechanical system<br>1.4.1 Free oscillations<br>1.4.2 Damped Oscillations<br>1.4.3 Forced oscillations without damping. | 8 **Hrs.** |
| **Unit 2: Vector Differential Calculus**<br>2.1 Differentiation of vectors<br>2.2 Velocity and acceleration<br>2.3 Gradient of scalar point function and Directional derivative<br>2.4 Divergence of vector point function<br>2.5 Curl of a vector point function<br>2.6 Solenoidal and Irrotational vector fields | 8 **Hrs.** |
| **Unit 3: Laplace Transform**<br>3.1 Definition, transforms of elementary functions, properties of Laplace transform<br>3.2 Transforms of derivative and integral<br>3.3 Inverse Laplace transform<br>3.4 Inverse Laplace transforms by using partial fractions and convolution theorem.<br>3.5 Solution of linear differential equations with constant coefficients by Laplace transform method. | 8 **Hrs.** |
| **Unit 4: Probability Distributions**<br>4.1 Random variable<br>4.2 Probability mass function and probability density function<br>4.3 Binomial distribution<br>4.4 Poisson distribution<br>4.5 Normal distribution | 6 **Hrs.** |
| **Unit 5: Fourier Series**<br>5.1 Definition, Euler's formulae, Dirichlet's conditions.<br>5.2 Functions having points of discontinuity<br>5.3 Change of interval<br>5.4 Expansion of odd and even periodic functions<br>5.5 Half range series | 6 **Hrs.** |
| **Unit 6: Application of Partial differential equations**<br>6.1 The method of separation of variables.<br>6.2 The Wave Equation. | 6 **Hrs.** |

| | |
|---|---|
| 6.2.1Fourier Series solution of wave equation.<br>6.3 One dimensional heat flow equation<br>6.3.1 Fourier Series solution of wave equation.<br>6.4 The Laplace equation in two dimensional heat flow (Steady State).<br>6.4.1 Numerical solutions of Laplace equation using Gauss – Siedel iterative method. | |

**Recommended Books:**

1. Higher Engineering Mathematics by Dr. B. S. Grewal, Khanna Publishers, Delhi.
2. A Text Book of Applied Mathematics, Vol. I and vol. II by P. N. Wartikar & J. N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune.

**Reference Books:**

1. Advanced Engineering Mathematics by Erwin Kreyszig, Wiley India Pvt. Ltd.
2. Advanced Engineering Mathematics by H. K. Dass, S. Chand, New Delhi.
3. A text book of Engineering Mathematics by N. P. Bali, Iyengar, Laxmi Publications (P) Ltd., New Delhi.
4. Mathematics for Engineers Vol-I & Vol-II by Rakesh Dube, Narosa Publishing House.

**Unit wise Measurable Learning Outcomes:**

**Unit 1: Linear Differential Equations with Constant Coefficients and Its Applications**

Students are able to

a) Solve linear differential equations with constant coefficients.
b) Solve the problems on free oscillation, damped oscillation and forced vibrations.

**Unit 2: Vector Differential Calculus**

Students are able to

a) Differentiate vector quantity.
b) Find the directional derivative of scalar point function.
c) Find the divergence and curl of vector point function.
d) Determine solenoidal and irrotational fields with the help of divergence and curl respectively.

**Unit 3: Laplace Transform**

Students are able to

a) Find Laplace transform by using definition
b) Recall properties of Laplace transform and use to find transforms of given functions.
c) Use Laplace transform method to solve linear differential equations.

**Unit 4: Probability Distributions**

Students are able to

a) Verify the function as probability mass and density function.
b) Use probability distributions in solving physical and engineering problems.

**Unit 5 : Fourier Series**

Students are able to

a) Define Fourier series, Euler's formulae.
b) Develop Fourier series in an interval.
c) Expand function as the half range sine or half range cosine series.

**Unit 6: Application of Partial differential equations**

Students are able to

a) Solve Wave Equation
b) Solve one dimensional heat equation
c) Find numerical solution to two dimensional heat equation.

| **Title of the Course: Engineering Thermodynamics** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0302 | **03** | **-** | | **3** |

**Course Pre-Requisite: Basic Physics, Chemistry, Basic Mechanical Engg**

Course Description: Basic Concepts in Thermodynamics, Forms of energy, Properties of pure substances, Phase diagram and Phase transition; First law of Thermodynamics and applications, Second Law of Thermodynamics and Exergy.

**Course Objectives:**

1. Understand various types of energies and its applications in thermodynamic systems
2. Applying thermodynamic concepts to thermodynamic systems
3. Know various laws of thermodynamics and applications to thermodynamic system
4. Application of ideal gas processes to thermodynamic systems
5. Study steam properties, Interpret steam tables and Mollier charts with numerical applications
6. Understand and analyze (numerical analysis) various types of air standard cycles

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | Explain fundamental knowledge of Thermodynamics and concept of Entropy Anergy, Exergy | II | Understanding |
| **CO2** | Explain principle of operation of Reciprocating Compressor and Gas Turbine | II | Understanding |
| **CO3** | Solve Numericals by using steam table and Mollier Chart | III | Analyzing |
| **CO4** | Classify Steam Boilers and Condensers | IV | Applying |

**CO-PO Mapping:**

| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 2 | | |
| **CO2** | 3 | | | | | | | | | | | | 2 | | |
| **CO3** | | 3 | | | | | | | | | | | | | |
| **CO4** | | | | 2 | | | | | | | | | 2 | | |

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

| **Course Contents:** | |
|---|---|
| **Unit 1:---**<br>Numerical treatment on second law, Clausius theorem, Entropy, Clausius inequality, Entropy as a property of system, Entropy of pure substance. T-s and h-s planes, Entropy change in a reversible and irreversible processes, Increase of entropy principle, Calculation of entropy changes of gases and vapors,(numerical treatment should be based on processes) Availability: Available and unavailable energy: availability of a closed and open system, Availability of work and heat reservoirs, Anergy and Exergy. | **8 Hrs.** |
| **Unit 2:---**<br>**Properties of Pure Substances :**<br>Pure substance, Phase change processes, Property diagram for phase change process (T-v, p-T, p-V diagram, p-v-T surface), Triple point of water, Properties of steam, Deviation of real gases from Ideal gases, Equations of state: Vander Waal, Beattie-Bridgeman, Virial and Diterici's equations.(Descriptive treatment) | **6 Hrs.** |
| **Unit 3:---**<br>**Gas Power Cycles:**<br>Air Standard cycles: Assumptions, the Carnot Cycle, Otto Cycle, Diesel Cycle and Dual Combustion Cycle. Comparison of Otto, Diesel and Dual Combustion Cycles. Expression for air standard efficiency and mean effective pressure for Otto, Diesel and Dual Combustion cycle. | **8 Hrs.** |
| **Unit 4:---**<br>**Vapour Power Cycles:**<br>Carnot cycle using steam, Limitations of Carnot cycle Rankine cycle, Representation on T-s and h-s planes, Thermal efficiency, Specific steam consumption. Work ratio, Effect of steam supply pressure and temperature, Effect of condenser pressure on the performance. (Numerical Treatment), Reheat and regenerative steam power cycles. Use of steam table and Mollier chart. | **6 Hrs.** |
| **Unit 5:---**<br>**Reciprocating Air Compressors:**<br>Application of compressed air, classification of compressor, Reciprocating compressors, construction , Work input, Necessity of cooling , Isothermal efficiency, Heat rejected, Effect of clearance volume, Volumetric efficiency, Necessity of multistaging, construction, Optimum intermediate pressure for minimum work required, After cooler, Free air delivered, air flow measurement, Capacity control. | **6 Hrs.** |
| **Unit 6:---**<br>**Gas turbines:**<br>Working principles, Applications, Gas Turbine Cycle-Brayton Cycle Ideal Brayton cycle. Calculation of gas turbine work ratio, Efficiency etc. Pressure ratio for maximum work.. Open cycle gas turbine-actual Brayton cycle. Methods for improvement of thermal efficiency of open cycle gas turbine plant. Effect of operating variables on thermal efficiency . Closed cycle gas turbine. | **6 Hrs.** |
| | |

**Textbooks:**

1.Thermodynamics: An Engineering Approach, 3rd Edition, Yunus A Çengel and Michael, Boles, Tata McGraw Hill.

2.Basic and Applied Thermodynamics, 2nd Edition, Nag P. K., Tata McGraw-Hill.

**References:**

1. Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics: Wiley.

2. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of Engineering

3. Jones, J. B., & Dugan, R. E. Engineering thermodynamics: Prentice Hall.

4. Potter, M. C., & Somerton, C. W. Schaum's Outline of Thermodynamics for Engineers, McGraw-Hill.

**Unit wise Measurable students Learning Outcomes:**

**After completion of unit , students are able to**

1. Explain fundamental of Thermodynamics like entropy, anergy, Exergy
2. Use Mollier chart and steam table
3. Explain fundamental knowledge of Rankine cycle
4. Classify steam generators and condensers
5. Solve Numericals on Reciprocating Compressor
6. Solve Numericals on Gas Turbine

| **Title of the Course: Engineering Thermodynamics** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0302 | **03** | **-** | | **3** |

**Course Pre-Requisite: Basic Physics, Chemistry, Basic Mechanical Engg**

Course Description: Basic Concepts in Thermodynamics, Forms of energy, Properties of pure substances, Phase diagram and Phase transition; First law of Thermodynamics and applications, Second Law of Thermodynamics and Exergy.

**Course Objectives:**

1. Understand various types of energies and its applications in thermodynamic systems
2. Applying thermodynamic concepts to thermodynamic systems
3. Know various laws of thermodynamics and applications to thermodynamic system
4. Application of ideal gas processes to thermodynamic systems
5. Study steam properties, Interpret steam tables and Mollier charts with numerical applications
6. Understand and analyze (numerical analysis) various types of air standard cycles

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | Explain fundamental knowledge of Thermodynamics and concept of Entropy Anergy, Exergy | II | Understanding |
| **CO2** | Explain principle of operation of Reciprocating Compressor and Gas Turbine | II | Understanding |
| **CO3** | Solve Numericals by using steam table and Mollier Chart | III | Analyzing |
| **CO4** | Classify Steam Boilers and Condensers | IV | Applying |

**CO-PO Mapping:**

| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 2 | | |
| **CO2** | 3 | | | | | | | | | | | | 2 | | |
| **CO3** | | 3 | | | | | | | | | | | | | |
| **CO4** | | | | 2 | | | | | | | | | 2 | | |

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

| **Course Contents:** | |
|---|---|
| **Unit 1:---**<br>Numerical treatment on second law, Clausius theorem, Entropy, Clausius inequality, Entropy as a property of system, Entropy of pure substance. T-s and h-s planes, Entropy change in a reversible and irreversible processes, Increase of entropy principle, Calculation of entropy changes of gases and vapors,(numerical treatment should be based on processes) Availability: Available and unavailable energy: availability of a closed and open system, Availability of work and heat reservoirs, Anergy and Exergy. | **8 Hrs.** |
| **Unit 2:---**<br>**Properties of Pure Substances :**<br>Pure substance, Phase change processes, Property diagram for phase change process (T-v, p-T, p-V diagram, p-v-T surface), Triple point of water, Properties of steam, Deviation of real gases from Ideal gases, Equations of state: Vander Waal, Beattie-Bridgeman, Virial and Diterici's equations.(Descriptive treatment) | **6 Hrs.** |
| **Unit 3:---**<br>**Gas Power Cycles:**<br>Air Standard cycles: Assumptions, the Carnot Cycle, Otto Cycle, Diesel Cycle and Dual Combustion Cycle. Comparison of Otto, Diesel and Dual Combustion Cycles. Expression for air standard efficiency and mean effective pressure for Otto, Diesel and Dual Combustion cycle. | **8 Hrs.** |
| **Unit 4:---**<br>**Vapour Power Cycles:**<br>Carnot cycle using steam, Limitations of Carnot cycle Rankine cycle, Representation on T-s and h-s planes, Thermal efficiency, Specific steam consumption. Work ratio, Effect of steam supply pressure and temperature, Effect of condenser pressure on the performance. (Numerical Treatment), Reheat and regenerative steam power cycles. Use of steam table and Mollier chart. | **6 Hrs.** |
| **Unit 5:---**<br>**Reciprocating Air Compressors:**<br>Application of compressed air, classification of compressor, Reciprocating compressors, construction , Work input, Necessity of cooling , Isothermal efficiency, Heat rejected, Effect of clearance volume, Volumetric efficiency, Necessity of multistaging, construction, Optimum intermediate pressure for minimum work required, After cooler, Free air delivered, air flow measurement, Capacity control. | **6 Hrs.** |
| **Unit 6:---**<br>**Gas turbines:**<br>Working principles, Applications, Gas Turbine Cycle-Brayton Cycle Ideal Brayton cycle. Calculation of gas turbine work ratio, Efficiency etc. Pressure ratio for maximum work.. Open cycle gas turbine-actual Brayton cycle. Methods for improvement of thermal efficiency of open cycle gas turbine plant. Effect of operating variables on thermal efficiency . Closed cycle gas turbine. | **6 Hrs.** |
| | |

**Textbooks:**

1.Thermodynamics: An Engineering Approach, 3rd Edition, Yunus A Çengel and Michael, Boles, Tata McGraw Hill.

2.Basic and Applied Thermodynamics, 2nd Edition, Nag P. K., Tata McGraw-Hill.

**References:**

1. Sonntag, R. E., Borgnakke, C., & Wylen, G. J. V. Fundamentals of thermodynamics: Wiley.

2. Moran, M. J., Shapiro, H. N., Boettner, D. D., & Bailey, M. Fundamentals of Engineering

3. Jones, J. B., & Dugan, R. E. Engineering thermodynamics: Prentice Hall.

4. Potter, M. C., & Somerton, C. W. Schaum's Outline of Thermodynamics for Engineers, McGraw-Hill.

**Unit wise Measurable students Learning Outcomes:**

**After completion of unit , students are able to**

7. Explain fundamental of Thermodynamics like entropy, anergy, Exergy
8. Use Mollier chart and steam table
9. Explain fundamental knowledge of Rankine cycle
10. Classify steam generators and condensers
11. Solve Numericals on Reciprocating Compressor
12. Solve Numericals on Gas Turbine

| **Title of the Course:** Fluid Mechanics | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0333 | 0 | 0 | 2 | 1 |

**Course Pre-Requisite:** The subject requires that the student should know about the various states of the substance, fundamental dimensions and units, vector calculus, basic fluid properties, the application of basic laws of mechanics, thermodynamics and orderly experimentation.

**Course Description:** This course aims to impart knowledge different flow patterns, flow and pressure measuring devices.

**Course Objectives:**

1. To introduce students about basics of fluid properties, pressure measurement techniques/ devices (using fluid).
2. To study basic concepts of fluid statics, buoyancy, floating and submerged bodies and its applications.
3. To study physical significance of fluid kinematics, fluid dynamics and it's applications.
4. To understand the different form of governing equation related to fluid flow.
5. To enable the students to analyze and evaluate fluid mechanics systems by applying principles of mathematics, science and engineering.
6. To develop skills in the analysis of fluid systems for lifelong learning.

**Course Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | **Bloom's Cognitive** | |
|---|---|---|---|
| | | **level** | **Descriptor** |
| **CO1** | Define fundamental properties of Fluid. | 2 | Understanding |
| **CO2** | Explain the fundamental concepts of fluid mechanics | 3 | Applying |
| **CO3** | Solve various fluid flow problems. | 3 | Applying |
| **CO4** | Analyze the energy losses in fluid flow systems. | 4 | Analyzing |

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | | | 2 | |
| CO3 | 3 | | | | | | | | | | | | | | |
| CO4 | | 2 | | | | | | | | | | | | | |

**Assessments :**

Teacher's Assessment based on – Laboratory performance, assignments, Tests, Report containing experiments (50%), Orals (50%) External examination, Performance (50%), Oral (50%).

| Assessment | Marks |
|---|---|
| ISE | 50 |
| ESE | 50 |

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

| Course Contents: | Duration |
|---|---|
| **Experiment No. 1:**<br>Flow visualization by plotting of streamlines (Heleshaw's apparatus).<br>**Aim and Objectives:** To visualise flow patterns by plotting streamlines.<br>**Outcomes:** Demonstrate use of Heleshaw's apparatus for flow visualisation<br>**Theoretical Background:** Definition of fluid, properties of fluid, types of flow.<br>**Experimentation:** Demonstration of Heleshaw's apparatus**.**<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 2:**<br>Viscosity of oil using Redwood viscometer<br>**Aim and Objectives:** To determine viscosity is of oil a time of flow in second through specified hole made in a metallic piece.<br>**Outcomes:** Viscosites for given sample with increase intemprature<br>**Theoretical Background:** Viscosity is a property of fluid that offers the resistance to flow it self-using redwood viscosity apparatus we can measure kinematic of oil<br>**Experimentation:** Calculation of Viscosity using redwood viscometer<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 3:** Reynold's Apparatus.<br>**Aim and Objectives:** To perform Reynold's experiment for determination of different types of flow.<br>**Outcomes:** Determination of Laminar, Transition & Turbulent flow.<br>**Theoretical Background:** Types of flow**.**<br>**Experimentation:** Calculation of Reynold's number with Interpretation.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 4:** Verification of Bernoulli's Equation.<br>**Aim and Objectives:** To verify Bernoulli's Equation.<br>**Outcomes:** Practical verification of Bernoulli's Equation.<br>**Theoretical Background:** Euler's Equation, Bernoulli's Equation & Assumptions.<br>**Experimentation:** Calculation & verification of Bernoulli's Equation.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 5:** Calibration of Venturimeter and Orificemeter.<br>**Aim and Objectives:** To calibrate Venturimeter and Orificemeter.<br>**Outcomes:** Calibration of Venturimeter and Orificemeter.<br>**Theoretical Background:** Discharge measurement by Venturimeter and Orificemeter.<br>**Experimentation:** Calculation of coefficient of discharge for Venturimeter and Orificemeter.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 6:** Calibration of Rectangular & Triangular notch.<br>**Aim and Objectives:** To calibrate Rectangular & Triangular notch.<br>**Outcomes:** Calibration of Rectangular & Triangular notch.<br>**Theoretical Background:** Discharge measurement by Rectangular & Triangular notch.<br>**Experimentation:** Calculation of coefficient of discharge for Rectangular & Triangular notch. | 02 Hrs |

| | |
|---|---|
| **Results and Discussions:**<br>**Conclusion:** | |
| **Experiment No. 7:** Orifice under steady & unsteady flow condition.<br>**Aim and Objectives:** To calculate hydraulic coefficients.<br>**Outcomes:** Study of steady & unsteady flow condition.<br>**Theoretical Background:** Definition & formula of hydraulic coefficients.<br>**Experimentation:** Calculation of hydraulic coefficients.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 8:** Determination of coefficient of friction in pipes of different materials.<br>**Aim and Objectives:** To determine coefficient of friction in pipes for different materials.<br>**Outcomes:** To calculate friction factor for different pipe material.<br>**Theoretical Background:** Derivation of coefficient of friction in pipes<br>**Experimentation:** Calculation for friction factor for different pipe material.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 9:** Determination of loss of friction in series pipes.<br>**Aim and Objectives:** To determine loss of friction in series pipes.<br>**Outcomes:** To calculate loss of friction in series pipes.<br>**Theoretical Background:** Derivation of head loss for major and minor losses.<br>**Experimentation:** Calculation of loss of friction in series pipes.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 10:** Determination of minor losses in pipe-fittings.<br>**Aim and Objectives:** To determine minor losses in pipe-fittings.<br>**Outcomes:** To estimate loss of head in pipe fittings such as sudden expansion, sudden contraction, bend & elbow.<br>**Theoretical Background:** Derivation of head loss for major and minor losses.<br>**Experimentation:** Calculation of loss of head in various pipe fittings.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Textbooks:**<br>1. Dr. P.N. Modi and Dr. S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House.<br>2. R.K.Bansal, "A Text book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications Pvt. Ltd.New Delhi.<br>3. S. K.Som, Gautam Biswas, Suman Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines" Tata McGraw – Hill Publication.<br>4. Hydraulics Fluid Mechanics and Fluid Machines By S. Ramamrutham. | |
| **Reference Books:**<br>1. White, "Fluid Mechanics", McGraw Hill Publication.<br>2. Cengel Yunus A. And Cimbala John M. "Fluid Mechanics and Fundamental and applications", Tata Mcgraw-Hill New Delhi.<br>3. Streeter, Wylie and Bedford, "Fluid Mechanics", Tata McGraw – Hill Publication. | |
| **Experiment wise Measurable students Learning Outcomes:**<br>1. Able to calibrate instrument.<br>2. To estimate the discharge through a pipe or open channels. | |

| **Title of the Course: Manufacturing Processes** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0304 | **3** | **--** | **---** | **3** |

**Course Pre-Requisite:** Basic Mechanical engineering, workshop practice-I, Engineering chemistry.

**Course Description:**

**Course Objectives:**

1. Acquire basic knowledge of manufacturing processes.
2. Understand principles of metal casting, metal joining and powder metallurgy.
3. Understand principle of metal and plastic forming.

**Course Outcomes:**

Students should be able to

1. ----

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE

**Course Contents:**

| | |
|---|---|
| **Unit 1:--- Fundamentals of Metal Casting**<br>Metal casting: Importance of casting, advantages, disadvantages and limitations of casting processes. Introduction and types of patterns, core boxes. Materials used and selection criteria for pattern, pattern allowances and colour codes used, Moulding and core processes: Types of sands used in moulding and core making, their properties. Sand moulding types such as Green sand Moulding, shell Moulding, $CO_2$ Moulding, Investment casting. Equipments and tools used for moulding and core making. Components of gating system, functions and importance of runners and risers, solidification control devices: chills, ceramics. Introduction to permanent mould casting processes such as Continuous casting, Gravity die casting, pressure die-casting, Centrifugal casting, Vacuum die casting, Squeeze casting. | 09 **Hrs.** |
| **Unit 2:--- Melting, Pouring and Modernization, Mechanization in Metal Casting**<br>Types of melting furnaces-Cupola furnace, oil/gas fired furnaces, crucible furnaces, Electrical furnaces, Rotary furnaces, etc. Furnace selection criteria their applications and melting practice on different furnaces. Metal pouring equipments, Cleaning-fettling of castings. Casting defects, their causes and remedies. Modernization, mechanization, use of computers in foundries and layout of foundry<br>. | 06 **Hrs.** |

| | |
|---|---|
| **Unit 3:---Metal Joining**<br>Welding Processes: Overview and classification of welding processes: Fusion welding, gas and arc welding, submerged arc welding, inert gas welding, Electric slag welding, Carbon-dioxide shielded welding, thermit welding, Pressure welding, solid phase welding and friction welding. | 06 **Hrs.** |
| **Unit 4:---Metal forming**<br>Metal Forming Processes: Nature of plastic deformation, hot working and cold working. Principles of rolling roll passes, roll pass sequences. Forging: Forging operations, smith forging, drop forging, press forging, forging defects. Extrusion and Sheet metal operations: Extrusion principle, hot extrusion, cold extrusion, wire drawing, swaging, tube making, rod making. Sheet metal operations: Press tools operations, shearing action, spinning, bending, stretch forming, embossing and coining. | 09 **Hrs.** |
| **Unit 5:---Plastic forming**<br>Fabrication of plastics: Thermosetting and thermoplastic materials, comparison with other materials, their properties and applications. Shaping of plastics: casting, blow moulding, compression moulding, transfer moulding, injection moulding, extrusion, thermoforming, rotational moulding, foam moulding and calendaring etc. Welding of plastics. | 05 **Hrs.** |
| **Unit 6:--- Powder metallurgy**<br>Principle, process, applications, advantages and disadvantages of powder metallurgy, Blending, compaction, sintering and metal injection molding:, Processes of powder making and mechanisms of sintering, process sheet for typical component. | 05 **Hrs.** |

**Textbooks:**


1. P. N. Rao, *"Manufacturing Technology- Foundry, Forming and Welding",* Vol. I, Tata McGraw-Hill, N 3rd edition, 2009.
2. P. L. Jain, *"Principles of Foundry Technology",* Tata McGraw-Hill, New Delhi, 2nd Edition,2006.
3. P. C. Sharma, *"A Textbook of Production Technology (Manufacturing Processes)",* S. Chand & Company, 2006.


**References:**


1. Machine Tools and Mfg. Technology, Steve F. Krar, Mario Rapisarda, Albert F. Check
2. O. P. Khanna, Foundry technology, Khanna Publishers, New Delhi.
3. P L Jain, Principles of foundry technology, Tata McGraw-Hill, New Delhi.
4. O. P. Khanna. Welding technology, Khanna Publishers, New Delhi.
5. Hajra Chowdhary, Elements of Workshop Technology, Vol.I, Media Promoters & Publications, Bombay

6. B.S. Raghuvanshi, W/S Technology, Vol. II, Dhanapat Rai Publi. Delhi, 10th Ed, 2000
7. W.A.J. Chapman, Workshop Technology, Vol. II, Viva Books, New Delhi,
8. Hajra Choudhury and A.K. Hajra Choudhury, Elements of Workshop Technology, Vol. II, S.K. Media Promoters and Publishers, New Delhi, 13th Edition, 2012.
9. Production Technology, R. K. Jain, Khanna Publishers, Delhi, 15th Edition, 2000.
10. Workshop Technology, W.A.J. Chapman, CBS Publishing and Distributors, N. Delhi Vol. I, 2001, Vol. I 2007 and Vol.III, 1995

**Unit wise Measurable students Learning Outcomes:**

1. Student will able to understand fundamentals of casting processes.
2.Student will able to understand metal pouring and modernization in metal casting process
3. Student will able to understand metal joining processes.
4. Student will able to understand different metal forming processes.
5. Students will be able understand plastic forming processes.
6. Student will able to understand powder metallurgy process.

# PROJECT BASED LEARNING (S.Y B.TECH)

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**COURSE NAME: MANUFACTURING PROCESS**
**COURSE CODE:**

**MPPBL 01: Casting**

Case study of any one component inclusive of drawing, pattern layout, pattern and core making/ die making, sand system used/ die material, moulding process, mould assembly, melting process, metal treatments, material cast specifications, pouring / casting, fettling and cleaning operations, coating given on casting/ any other surface treatment, heat treatment if any, types of equipments/ machines used, defects and defect analysis, testing.

(Green sand process, $Co_2$ process, investment casting, die casting (Pressure / die casting) centrifugal casting)

**MP PBL 02: Welding**

Case study of any one component inclusive of drawing, types of joint, process used, process parameters, heat treatment if any, material welded specifications, defects and defect analysis, testing.

(Gas welding, arc welding, MIG welding, Resistance welding)

**MPPBL03: Metal forming.**

Case study of any one component inclusive of drawing, types of forming process, die/ tool design, die/ tool material, process parameters, heat treatment if any, material formed specifications, defects and defect analysis.

(Cold forming, hot forming, forging, extrusion, wire drawing, sheet metal operations)

**MPBL04: Plastic forming/ Powder metallurgy.**

**Plastic forming**

Case study of any one component inclusive of drawing(if any), die/ tool design, die/ tool material, specifications of machine used, plastic material used, type of moulding, defects and defect analysis.

Or

**Powder metallurgy**

Case study of any one component inclusive of drawing (if any), powder material/ materials, process of powder manufacturing, die design, die material, process parameters for mixing, compacting, sintering and post processes.

**2. Activities with timeline:**

| Sr. No. | Activity | Timeline |
|---|---|---|
| 1 | PBL awareness in the class | 1st week (17-21 July 2018) |
| 2 | Announcement of problem after PBL and Team formation | 2nd week (24-28 July 2018) |
| 3 | Visits to Industries. | 29th July and 5th August 2018 |
| 4 | Project ISEI: Synopsis presentation | 4th week (7-11 August 2018) |
| 5 | Completion of corrections/ Improvement in synopsis | 5th week (14-18 August 2018) |
| 6 | Project ISE II: Project progress presentation with model or case study | 10th week (11-15 September 18 ) |
| 7 | Completion of correction/ Improvement II (Evaluation II) | 11th week (18- 22 September 18 ) |
| 8 | End semester evaluation of project | 13th week (02- 06 October 18 ) |
| 9 | Determining future scope for project | 14th week (09- 13 October 18) |

**3. Assessment Scheme:**

ISE I : 10 marks

ISE 2: 10 marks

ISE workshop II : 15 marks

**4. Evaluation Scheme**:

Project ISEI: Synopsis presentation with 10 marks

Project ISE II: Project progress presentation with model/case study for 15 marks

End semester Evaluation of project : Multmedia presentation and demonstration of working models for 15 marks out of 25 of workshop II ISE.

| **Title of the Course: Machine Drawing and Computer Aided Drafting**<br><br>**Course Code:** UMCH0305 | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| | **3** | **1** | **--** | **4** |

**Course Pre-Requisite:** - 1. Fundamentals of Engineering Drawing
2. Basic knowledge of 2-D drafting using software

**Course Description:** Machine Drawing and Computer Aided Drafting is offered as credit course at the third semester of Mechanical Engineering under Graduate programme. It is used to communicate the necessary technical information required for manufacture and assembly of machine components. These drawings follow rules laid down in national and International Organizations for Standards (ISO). Hence the students will be aware of the different standards. Students will to be familiar with industrial drafting practices and thorough understanding of production drawings to make themselves fit in industries .This course enables students to create 2D model, Assembly, Bill of material and drafting of any mechanical components. Students will construct 3 models. Topics will include sketching, constraining, solid modeling, Drafting and Assembly modeling

**Course Objectives:**

1. To make the student familiar with Indian Standards for drawing.
2. To use different limits, fits and tolerances on assembly drawings.
3. To provide sound knowledge of detail and assembly procedure.
4. To build/Construct Build 2D sketches fulfilling appropriate dimensional and geometrical constraints using CAD software
5. To design 3D solid Models of parts using CAD software.
6. To Construct 2D projections from 3D models and assemblies.
7. To Develop 3D assemblies using CAD software taking into consideration appropriate assembly approach

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | Demonstrate the various BIS conventions in machine drawing | II | Understanding |
| **CO2** | Interpret the geometrical dimensioning and tolerance used in industrial drawing | II | Understanding |
| **CO3** | Make use of free hand sketches for drawing simple machine components | III | Applying |
| **CO4** | Construct the detail part and assembly drawing | III | Applying |
| **CO5** | Develop the Interpretation curves for two mating parts | III | Applying |
| **CO6** | Design and develop 3D solid Models and 3D assemblies using CAD software. | VI | Develop |

CO-PO Mapping:

| CO | PO 1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | - | - |
| CO2 | 2 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | - | - |
| CO3 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO4 | 2 | - | 2 | - | - | - | - | - | - | - | - | - | - | - | - |
| CO5 | 2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| CO6 | - | - | - | - | 3 | - | - | - | - | - | - | 1 | - | - | - |

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

**Course Contents:**

**Unit No. 1:---** **2Hrs.**

**Study of B.I.S.(Bureau of Indian Standards) Conventions**

Significance and importance of various BIS Conventions as per standards, Drawings sheet sizes and layout, Dimensioning Techniques, Conventional representation of engineering materials, BIS conventions for sectioning, conventional representation of screw threads and threaded parts, Internal and external threads, springs, gears and gearings, conventional representation of common machine elements (splined shaft, serrated shaft, Knurling, bearings *etc.*). Symbolic representation of Welds, Rivets and riveted joints as per BIS conventions.

**Unit No. 2:--** **8 Hrs.**

**A)Sketching of machine components**

Free Hand drawing on Nuts, bolts, studs, washers with different types of locking arrangements of nuts, Conventional representation of threaded parts in external and internal views with sections and assembly. Types of keys: Parallel, sunk, woodruff, saddle, feather etc. Types of keys couplings: flexible and Rigid couplings, Types of bearings: Simple, Solid, bushed, I. S. conventional representation of ball and roller bearings, Pipe Joints and fittings: Different types of pipe Joints like Expansion joints, piping layouts, valves , pipe fittings like sockets, nipples, plugs, bends, Tees, elbows, crosses, etc. Power transmission elements: Flat belt, V belt, gears, chains, ropes, sprockets

| | |
|---|---|
| B) **Interpenetration of Solids:**<br>Intersection of surfaces and solids: - Intersection of prisms, cylinders, cone with prism & cylinder, pyramid with prism, and vice versa both solids in simple position. (Prisms and Pyramids limited up to Rectangular base) | |
| **Unit No. 3:--- Geometrical Dimensioning and Tolerances**<br>Significance of limit systems, terminology, Dimensional Tolerances, types of fits, Recommendations and selections, Geometric Tolerances, Nomenclature, Rules, Symbols, form and position, Representation of geometric tolerances on drawing, giving Tolerances for individual dimensions on a detail drawing. Roughness Grades, Representation of surface roughness on drawing (Machining symbol), Relation between surface finish & Manufacturing processes. | **4 Hrs.** |
| **Unit No. 4:--- Production Drawing**<br>Assembly and part drawings (Machine tool parts, Engine parts, Valves, Jigs and Fixtures, Fabricated assembly) study and preparation of bill of materials. Entering limits, fits, tolerances and surface finish symbols on detail and assembly drawing | **8 Hrs.** |
| **Unit No. 5:A) Introduction to Computer Aided Design:** Concept of CAD/CAM/CAE Need for implementing CAD, Application and benefits of CAD, Hardware Requirements, Various Software packages used for 3D Modeling.<br>**B) Sketching:**<br>2D sketching of elements like line, circle, arc, spline etc. Dimensioning these elements, Geometrical constraints like parallel, perpendicular, co-incident, vertical, horizontal, tangent, symmetric etc.<br>**Generation of Solid models** Import and export of 3D solid models between two different software packages. Physical properties like volume, surface area, center of gravity etc of solid model. | **10 Hrs.** |
| **Unit No. 6:**<br>**A)Assembly Modeling**: Concept of Bottom up and top down approach, Building two composite assemblies of components (consisting at least five components) along with all relevant details, Exploded Views using assembly features in any suitable 3D modeling software. Introduction to Kinematic Simulation of assembly using appropriate tool in the high end CAD software.<br><br>**B)Generation of 2D Drawings:**<br>Generation of Orthographic views of individual components required for shop floor [working drawings] from 3D model which will include all relevant views like front, side, top, bottom views, sectional views, dimensioning, dimensional and geometrical tolerances etc. Generation of title block in sheet. Orthographic views of assembly drawings, generation of Bill of Materials (BOM). Plotting of drawings. | **8 Hrs.** |

**Textbooks:**


1. K. L. Narayana, Dr. P. Kannaiah, and K. Venkata Reddy, "Machine Drawing",New Age International Publishers, New Delhi
2. N. D. Bhatt & V. M. Panchal, "Machine Drawingby", Charotar Pub, Anand, Gujarat
3. P. S. Gill, "A Textbook of Machine Drawing", S. K. Kataria& sons, New Delhi
4. N. D. Junnarkar, "Machine Drawing", Pearson Education
5. R.K. Dhavan, "Machine Drawing", S. Chand and Company, New Delhi

6. N.Sidheshwar, P.Kannaiah and V.V. Shastry, "Machine Drawing"McGraw Hill,2001
7. CATIA V5 R20 for Engineers by SHAM TICKOO

**References:**


1. IS Code: SP 46 – 1988, Standard Drawing Practices for Engineering Institutes
2. "Design Data", Faculty of Mechanical Engineering, PSG College of Tech, Coimbatore
3. IS : 2709-Guide for Selection of Fits, B.I.S. Publications
4. IS:919-Recommendation for Limits and Fits for Engineering, B.I.S. Publications
5. IS: 8000-Part I, II. III. TV, Geometrical Tolerencing of Technical Drawings –B.I.S. Publications
6. I.S.:696 Code of practice for general engineering drawings. BIS Publication.
7. I.S.:2709 Guide for selection of fits. BIS Publication.


**Unit wise Measurable students Learning Outcomes:**

1. To get familiar with Bureau of Indian Standards drawing conventions.
2. To be able to draw proportionate free hand sketches of standards machine components and understanding penetration curves of solids.
3. To understand the use of limits, fits and tolerances with respect to assembly drawings
4 To be able to prepare detail drawings from given assembly drawings and vice a versa.
5. Students shall be able to Construct 2D projections from 3D models using CAD software
6.To Develop 3D assemblies using CAD software taking into consideration appropriate assembly approach

| **Title of the Course :ELECTRICAL TECHNOLOGY**<br>**Course Code:** UMCH361 | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| | **02** | **-** | **-** | **-** |
| **Course Pre-Requisite**:Applied physics | | | | |

**Course Objective**:

| **CO** | | Blooms level | Descriptor |
|---|---|---|---|
| **CO1** | Recall the principles of electrical engineering | 1 | Remembering |
| **CO2** | Explain the construction and operating principles of motors | 2 | Understanding |
| **CO3** | Explain the construction and working of Electric heating devices. | 2 | Understanding |
| **CO4** | Select suitable electrical drives for mechanical systems | 3 | Applying |

**PO MAPPING**

| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | - | - | - | - | - | - | - | - | - | - | | | | |
| 2 | - | - | - | - | - | - | - | - | - | - | | | | |
| 2 | - | - | - | - | - | - | - | - | - | - | | | | |
| 2 | 2 | - | - | - | - | - | - | - | - | - | | 2 | | |

**Teachers assessment**

End Semester Examination (ESE) for 100 marks

| **Assessment** | **Marks** |
|---|---|
| ESE | 100 |

| | |
|---|---|
| **Unit 1: D C Motor**<br>Construction, working, types, equivalent circuit, back emf, speed equation, torque equation, speed torque characteristics, power losses, applications, Need of starter, 3 point starter, 4 point starter, reversal of rotation, Electric braking, DC servo motor - desirable features, types and applications. Stepper motor- desirable features, types and applications. | **7 Hrs** |
| **Unit 2:--- 3 phase AC motor:**<br>3 phase induction motor- Construction, working, types, speed equation, torque equation, speed torque characteristics, power losses, applications, Need of starter, star delta starter, DOL starter, autotransformer starter, rotor resistance starter, reversal of rotation, Electric braking | **7 Hrs.** |
| **Unit 3:---Mechanical Testing**<br>Benefits of electric drive, individual drive, multimotor drive. Types of mechanical load (Based on speed-torque variation, active/passive load.) Concept of stable operating characteristics of electric motor under load variations. | **7 Hrs.** |

| | |
|---|---|
| DC motor Speed control – armature control, field control(Numerical treatment ), 3 phase induction motor Speed control - voltage control, V/f control, rotor resistance speed control (Numerical treatment)<br>Electrical to mechanical Energy conversion (Numerical Treatment). | |

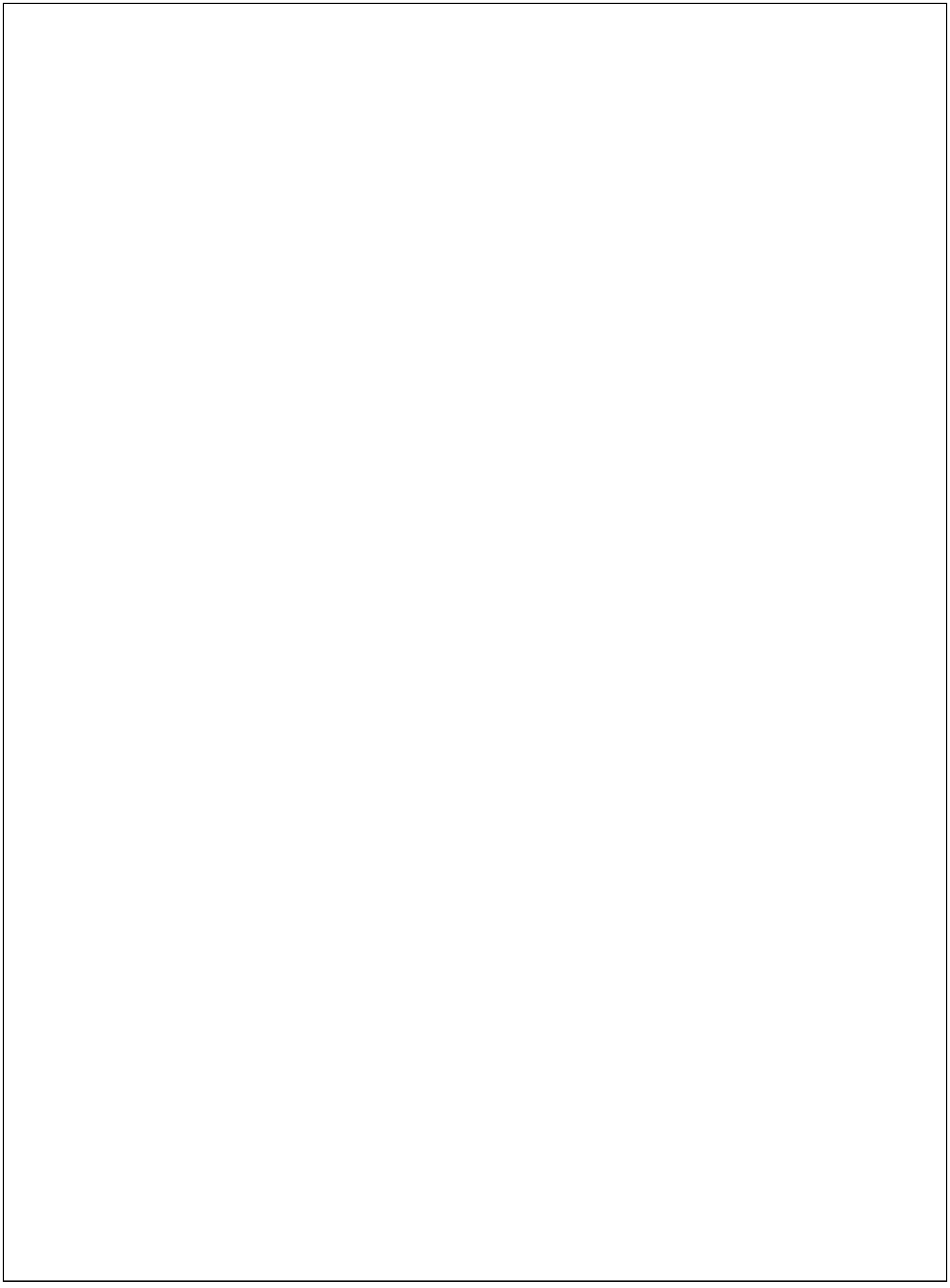
**Textbooks:**

**Text Books:**

1. Electrical Technology (Vol. II)- B. L. Theraja ,S. Chand Publ.
2. Utilllization of Electric power- R.K.Rajput, Laxmi Publ.

**References:**

1. Electrical power – S. L. Uppal, DBS Publ
2. First course in Electrical Drives- Pillai S.K – Willey Eastern



| **Title of the Course:** Object Oriented Programming Lab | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0330 | **0** | **0** | **2** | **1** |

**Course Pre-Requisite:** Basic Electronics and Computer Programming in 'C'

**Course Description:**

This subject exposes the learner to the various typical object oriented concepts like, classes, objects, inheritance, Operator Overloading etc. It also makes the reader realize the advantages of object oriented Programming Methodology over the conventional procedural programming methodology. This course encourages students to solve real life problems by designing and developing real time application using object oriented programming language.

**Course Objectives:**

1. To develop and enhance the programming skills amongst the students in general as well as application of it in the field of Mechanical Engineering.
2. To introduce an object oriented programming language.

**Course Learning Outcomes:**

Ability to distinguish C and C++, learn basic programming using C++

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | **Distinguish** between object oriented programming and procedural programming. | 1 | Knowledge |
| **CO2** | **Apply** their knowledge and programming skills to solve various computing problems in the field of Mechanical Engineering. | 3 | Application |
| **CO3** | **Design** and **Develop** small C++ application to solve real time problems. | 3, 6 | Application, Create |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | 2 | 2 | | |
| CO2 | 3 | 2 | | | | | | | | | | 2 | 3 | 2 | |
| CO3 | | 2 | 2 | | | | | | 2 | | | 2 | 3 | 2 | 2 |

**Assessments:**

**Teacher Assessment:**

One component of in Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE | 50 |
| ESE | 50 |

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

**Course Contents:**

| | |
|---|---|
| **Experiment No. 1: ---** Assignment on concepts of object oriented programming.<br>**Theoretical Background:** Importance of OOP, Introduction to object oriented programming, programming paradigms, Difference between C and C++. | **4 Hrs.** |
| **Experiment No. 2: ---** Programs on control structures and functions<br>**Theoretical Background: C++ Declaration & Control structure (Moving from C to C++)** | **4 Hrs.** |

| | |
|---|---|
| Data-type, variables, Reference variable (Definition and sample program), constants, operators in C & C++ (With simple programs as examples), Control Flow Structure (If, If-else, Loops- Illustration with simple programs), Arrays, Strings and pointers (Concept only), Functions, Types of functions. | |
| **Experiment No. 3: ---** Programs on concept of classes and objects<br>**Theoretical Background: Classes and Objects**<br>Abstraction mechanisms: Classes, Objects, private, public & Protected (Simple programs)<br>Constructor, types of constructors, destructor (With examples) | **4 Hrs.** |
| **Experiment No. 4: ---** Programs using inheritance and polymorphism.<br>**Theoretical Background: Extending Classes**<br>Inheritance: Types of Inheritance (With examples), Polymorphism, Types of Polymorphism (with Examples). | **4 Hrs.** |
| **Experiment No. 5: ---**<br>Design problem on stock and accounting of a small organization, payroll preparation, costing and invoice preparation, sample artificial intelligence examples, solution to sample mechanical engineering design and analysis problems, optimization problem.<br>**Theoretical Background:** A C++ practical application development using knowledge gained in above experiments. | **8 Hrs.** |
| **Textbooks:**<br>1. Object oriented programming with C++, E. Balagurusamy, Tata McGraw Hill Education ,3rd Edition<br>2. Let us C++" ,Yashwant Kanitkar ,BPB Publication<br>3. "Object-Oriented Programming in C++", Rajesh K Shukla, Wiley India<br>4. Classic Data structures by Samantha, PHI Learning Pvt.Ltd, 2nd Edition. | |
| **References:**<br>1. "Professional C++", Solterwiely India.<br>2. Problem solving with C++, The OOP, Fourth edition, W.Savitch, Pearson education.<br>3. Data structures and Algorithm Analysis in C++, Mark Allen Weiss, Pearson Education.PvtLtd., Second Edition<br>4. An introduction to Data structures and algorithms, J.A.Storer,Springer. | |

Curriculum is framed by considering syllabus and inputs from following sources:

1. F.Y.B.Tech. Curriculum for Computer programming using 'C' of KIT's COEK.
2. VIT Vellore syllabus for the subject problem solving using 'C'. (2 Hours Lecture and 2 Hours Practical Per week)
3. Rajarambapu Institute of Technology Curriculum for the subject computer programming. (3 Hours lectures and 2 hours practical per week)
4. Interaction with Director, Bentley Systems Ltd., Pune.
5. Pre-DAC syllabus (Entrance Exam for CDAC courses).

| **Title of the Course: Machine Drawing and CAD Lab** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0331 | **--** | **--** | **2** | **1** |

**Course Pre-Requisite:** 1. Fundamentals Engineering Drawing
2. Basic knowledge of 2-D drafting using software

**Course Description:** Students will to be familiar with industrial drafting practices and thorough understanding of production drawings to make themselves fit in industries. This course enables students to create 2D, Assembly, Bill of material and drafting of any mechanical components. Students will learn to apply principles of technical drawing and acquire skills in the use of appropriate computer aids

**Course Objectives:**

1. To make the student familiar with Indian Standards for drawing.
2. To build/Construct Build 2D sketches fulfilling appropriate dimensional and geometrical constraints using CAD software
3. To Construct 2D projections from 3D models and assemblies
4. To Develop 3D assemblies using CAD software taking into consideration appropriate assembly approach

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| 1 | Demonstrate the various BIS conventions in machine drawing | II | Understanding |
| 2 | Make use of free hand sketches for drawing simple machine components | III | Applying |
| 3 | Build 2D sketches fulfilling appropriate dimensional and geometrical constraints using CAD software. | III | Applying |
| 4 | Design basic and advanced 3D solid Models of parts using CAD software. | IV | Analyzing |
| 5 | Construct 2D projections from 3D models and assemblies | IV | Analyzing |
| 6 | Develop 3D assemblies using CAD software taking into consideration appropriate assembly approach | VI | Creating |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | - | - |
| CO2 | 2 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | - | - |
| CO3 | 1 | - | - | - | 3 | - | - | - | - | - | - | 1 | - | - | - |
| CO4 | 1 | - | - | - | 3 | - | - | - | - | - | - | 1 | - | - | - |
| CO5 | 1 | - | - | - | 3 | - | - | - | - | - | - | 1 | - | - | - |
| CO6 | 1 | - | - | - | 3 | - | - | - | - | - | - | 1 | - | - | |

**Assessments :**

**Teacher Assessment:**

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE)

having 50%, and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE | 25 |
| ESE(POE) | 25 |

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.
ESE: Assessment is based on oral examination

**Course Contents:**

| | |
|---|---|
| **Sheet No. 1:---** Based on BIS conventions<br>**Aim and Objectives:** To draw BIS conventions on A2 Sized Sheet<br>**Outcomes:** Student will be familiar with Indian Standards for drawing<br>**Theoretical Background:** Study of various BIS conventions | **2Hrs.** |
| **Sheet No. 2:---** Based on free hand sketching<br>**Aim and Objectives:** To draw free hand sketching on A3 Sized Sheet<br>**Outcomes:** Free hand sketching is used so as to enable the students to quickly present , in graphical form ,an idea which is related to particular problem.<br>**Theoretical Background:** Study of machine components. | **2Hrs.** |
| **Sheet No. 3:---** Based on free hand sketching<br>**Aim and Objectives:** To draw free hand sketching on A2 Sized Sheet<br>**Outcomes:** Free hand sketching is used so as to enable the students to quickly present , in graphical form ,an idea which is related to particular problem.<br>**Theoretical Background:** Study of machine components. | **2 Hrs.** |
| **Sheet No. 4:---** Based on Interpenetration of Solids<br>**Aim and Objectives:** To draw Interpenetration of solids A3 Sized Sheet<br>**Outcomes:** Students will be able to develop the Interpretation curves for two mating parts<br>**Theoretical Background:** Study of section of solids. | **2 Hrs.** |
| **Sheet No. 5:---**Based on preparing Assembly and Details and showing GD&T and surface roughness symbols on drawing using drafting software on A3 Sized Sheet.<br>**Aim and Objectives:** To draw Assembly and Details of machine component using drafting software on A3 Sized Sheet.<br>**Outcomes:** Students will be able to understand and draw the assembly of machine components. | **3 Hrs.** |
| **Sheet No. 6:---** Based on preparing Assembly and Details and showing GD&T and surface roughness symbols on drawing using drafting software on A3 Sized Sheet.<br>**Aim and Objectives:** To draw Assembly and Details of Jigs and Fixtures using drafting software on A3 Sized Sheet.<br>**Outcomes:** Students will be able to understand and draw the assembly of Jigs and Fixtures | **3Hrs.** |
| **Sheet No. 7:---** Based on preparing Assembly and Details and showing GD&T and surface roughness symbols on drawing using drafting software on A3 Sized Sheet. | **3Hrs** |

| | |
|---|---|
| **Aim and Objectives:** To draw Assembly and Details of Fabricated parts using drafting software on A3 Sized Sheet.<br>**Outcomes:** Students will be able to understand and draw the assembly of Fabricated parts | |
| **Sheet No. 8** Based on generation of Solid models of at least 6 simple industrial components and converting it into orthographic views using High End CAD sotware and printing it on A4 size sheet.<br>**Aim and Objectives:**To draw Solid models of a simple industrial components<br>**Outcomes:** Students will be able to generate solid model and convert into orthographic views | **3Hrs** |
| **Sheet No. 9** Based on generation of Assembly models of at least 2 assemblies and converting it into orthographic views using High End CAD software and printing it on A3 size sheet.<br>**Aim and Objectives:** To generate Assembly models.<br>**Outcomes:** Students will be able to generate assembly and convert it into orthographic views. | **3Hrs** |

**Textbooks:**


1. K. L. Narayana, Dr. P. Kannaiah, and K. Venkata Reddy, "Machine Drawing",New Age International Publishers, New Delhi
2. N. D. Bhatt & V. M. Panchal, "Machine Drawingby", Charotar Pub, Anand, Gujarat
3. P. S. Gill, "A Textbook of Machine Drawing", S. K. Kataria& sons, New Delhi
4. N. D. Junnarkar, "Machine Drawing", Pearson Education
5. R.K. Dhavan, "Machine Drawing", S. Chand and Company, New Delhi
6. N.Sidheshwar, P.Kannaiah and V.V.S.Sastry, "Machine Drawing"McGraw Hill,2001.
7. CATIA V5 R20 for Engineers by SHAM TICKOO


**References:**


1. IS Code: SP 46 – 1988, Standard Drawing Practices for Engineering Institutes
2. "Design Data", Faculty of Mechanical Engineering, PSG College of Tech, Coimbatore
3. IS : 2709-Guide for Selection of Fits, B.I.S. Publications
4. IS:919-Recommendation for Limits and Fits for Engineering, B.I.S. Publications
5. IS: 8000-Part I, II. III. TV, Geometrical Tolerencing of Technical Drawings –B.I.S. Publications
6. I.S.:696 Code of practice for general engineering drawings. BIS Publication.
7. I.S.:2709 Guide for selection of fits. BIS Publication.


**Measurable students Learning Outcomes:**

1. To get familiar with Bureau of Indian Standards drawing conventions.
2.To be able to draw proportionate free hand sketches of standards machine components.
3. Understanding penetration curves of solids.
4. Ability to use standard drafting software for showing limits, fits and tolerances and surface roughness symbols with respect to assembly drawings and detail drawings.
5. To be able to prepare detail drawings from given assembly drawings and vice a versa.
6. Students shall be able to Construct 2D projections from 3D models using CAD software
7.To Develop 3D assemblies using CAD software taking into consideration appropriate assembly approach

| **Title of the Course: Thermal Engineering Lab** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0332 | **0** | **0** | **2** | **1** |

**Course Pre-Requisite: Basic Mechanical Engineering, Physics**

**Course Description:** Basic Concepts in Thermodynamics, Working of Steam generator and Condenser, Working Principle of Reciprocating compressor, Working Principle of Gas Turbine

**Course Objectives:**

1. To Understand types and working of Steam Boilers and steam condensers.
2. To Demonstrate working of Steam calorimeters.
3. To Determine Thermo physical properties of Lubricating oil and Grease
4. To estimate efficiency of Reciprocating Compressor

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | Classify Steam Boilers and steam condensers | II | Understanding |
| **CO2** | Explain working principle of Steam Calorimeter | II | Understanding |
| **CO3** | Determine Thermo physical properties of Lubricating oil and Grease | V | Evaluating |
| **CO4** | Estimate efficiency of Reciprocating compressor | V | Evaluating |

**CO-PO Mapping:**

| **CO** | **PO1** | **PO2** | **PO3** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 2 | | | |
| **CO2** | 3 | | | | | | | | | | | | 2 | | | |
| **CO3** | 3 | | 2 | | | | | | | | | | 2 | | | |
| **CO4** | | 2 | 3 | | | | | | | | | | 2 | | | |

**Assessments :**

**Teacher Assessment:**

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE | 50 |
| ESE | 50 |

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

| **Course Contents:** | |
|---|---|
| **Experiment No. 1:--- Test On Carbon Residue Apparatus**<br>**Aim and Objectives:** To determine the percentages of carbon residue after evaporation of oil. | 2 Hrs |
| **Experiment No. 2:--- Determination of Flash and Fire Point of Lubricating Oil**<br>**Aim and Objectives:** Determination of flash and fire point of given lubricating oil. | 2 Hrs |
| **Experiment No. 3:--- Test on Dropping point apparatus**<br>**Aim and Objectives:** To determine the dropping point of lubricating grease | |
| **Experiment No. 4:--- Test on Aniline Point apparatus**<br>Aim and Objectives: To determine the aniline point of given lubricating oil. | 2 **Hrs.** |
| **Experiment No. 5:--- Study and demonstration of Steam condensers**<br>**Aim and Objectives:** To Classify and explain working of Steam Condenser and calculation of performance parameters of condenser.<br>**Outcomes:** Students are able to Classify and explain working of various steam Condenser and determine performance parameters. | 2 **Hrs.** |
| **Experiment No. 6:--- Study and Demonstration of Steam Boilers**<br>**Aim and Objectives:** To Classify and explain working of Steam Boilers<br>**Outcomes:** Students are able to Classify and explain working of various Steam Boilers | 2 **Hrs.** |
| **Experiment No. 7:--- Study and demonstration of Boiler mounting and Accessories**<br>**Aim and Objectives:** To Classify and explain working of Boilers Mounting and accessories<br>**Outcomes:** Students are able to Classify and explain working of various Boilers mountings and accessories | 2 Hrs |
| **Experiment No. 8:--- Study and demonstration of calorimeters**<br>**Aim and Objectives:** To Classify and explain working of Steam Calorimeter<br>**Outcomes:** Students are able to Classify and explain working of various steam Calorimeter | 2 **Hrs.** |
| **Experiment No. 9:--- Trial on Reciprocating Compressor**<br>**Aim and Objectives:** To determine thermal and volumetric efficiency of reciprocating compressor.<br>**Outcomes:** Students are able to determine thermal and volumetric efficiency of Reciprocating Compressors | 2 **Hrs.** |
| **Experiment No. 10:--- Industrial visit to steam power plant.**<br>**Aim and Objectives:** To Classify and explain working of Steam Boilers, mounting and accessories<br>**Outcomes:** Students are able to Classify and explain working of various steam Boilers, mounting and accessories. | 2 **Hrs.** |
| | |

**Textbooks:**

1Thermodynamics: An Engineering Approach, 3rd Edition, Yunus Çengel and Michael, Boles, Tata McGraw Hill.

2.Basic and Applied Thermodynamics, 2nd Edition, Nag P. K., Tata McGraw-Hill.

**References:**

1.Fundamentals of Thermodynamics, 5th Edition, Richard E. Songtag, Claus Borgnakke and Gordon J. Van Wylen, John Wiley and Sons, Inc.

2.Thermodynamics, 4th Edition, J.P. Holman, McGraw-Hill.

3.Engineering Thermodynamics, 2nd Edition, Jones J.B. and Hawkins G.A., John Wyley and Sons.

4.Fundamentals of Engineering Thermodynamics, Moran M.S. and Shapiro H.N., John Wyley and Sons, 1988.

5.Thermodynamics, 5th Edition, K. Wark, McGraw-Hill.

**Experiment wise Measurable students Learning Outcomes: At the end of each experiment the students will be able to**

1. **Determine Percentage of Carbon Residue in Lubricating Oil.**
2. **Determine Flash and Fire point of Lubricating oil**
3. **Determine Dropping point of Lubricating oil**
4. **Determine Aniline point of Lubricating oil**
5. **Demonstrate working of Steam Condensers**
6. **Demonstrate working of Steam Boilers**
7. **Demonstrate working of Boiler mountings and accessories.**
8. **Demonstrate working of Steam Calorimeter**
9. **Determine Efficiency of Reciprocating Compressor.**

| **Title of the Course:** Fluid Mechanics Lab | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0333 | 0 | 0 | 2 | 1 |

**Course Pre-Requisite:** The subject requires that the student should know about the various states of the substance, fundamental dimensions and units, vector calculus, basic fluid properties, the application of basic laws of mechanics, thermodynamics and orderly experimentation.

**Course Description:** This course aims to impart knowledge different flow patterns, flow and pressure measuring devices.

**Course Objectives:**

1. To introduce students about basics of fluid properties, pressure measurement techniques/ devices (using fluid).
2. To study basic concepts of fluid statics, buoyancy, floating and submerged bodies and its applications.
3. To study physical significance of fluid kinematics, fluid dynamics and it's applications.
4. To understand the different form of governing equation related to fluid flow.
5. To enable the students to analyze and evaluate fluid mechanics systems by applying principles of mathematics, science and engineering.
6. To develop skills in the analysis of fluid systems for lifelong learning.

**Course Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | **Bloom's Cognitive** | |
|---|---|---|---|
| | | **level** | **Descriptor** |
| **CO1** | Define fundamental properties of Fluid. | 2 | Understanding |
| **CO2** | Explain the fundamental concepts of fluid mechanics | 3 | Applying |
| **CO3** | Solve various fluid flow problems. | 3 | Applying |
| **CO4** | Analyze the energy losses in fluid flow systems. | 4 | Analyzing |

**CO-PO Mapping:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | | | | |
| CO2 | 3 | | | | | | | | | | | | | 2 | |
| CO3 | 3 | | | | | | | | | | | | | | |
| CO4 | | 2 | | | | | | | | | | | | | |

**Assessments :**

Teacher's Assessment based on – Laboratory performance, assignments, Tests, Report containing experiments (50%), Orals (50%) External examination, Performance (50%), Oral (50%).

| Assessment | Marks |
|---|---|
| ISE | 50 |
| ESE | 50 |

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

ESE: Assessment is based on oral examination

| Course Contents: | Duration |
|---|---|
| **Experiment No. 1:**<br>Flow visualization by plotting of streamlines (Heleshaw's apparatus).<br>**Aim and Objectives:** To visualise flow patterns by plotting streamlines.<br>**Outcomes:** Demonstrate use of Heleshaw's apparatus for flow visualisation<br>**Theoretical Background:** Definition of fluid, properties of fluid, types of flow.<br>**Experimentation:** Demonstration of Heleshaw's apparatus**.**<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 2:**<br>Viscosity of oil using Redwood viscometer<br>**Aim and Objectives:** To determine viscosity is of oil a time of flow in second through specified hole made in a metallic piece.<br>**Outcomes:** Viscosites for given sample with increase intemprature<br>**Theoretical Background:** Viscosity is a property of fluid that offers the resistance to flow it self-using redwood viscosity apparatus we can measure kinematic of oil<br>**Experimentation:** Calculation of Viscosity using redwood viscometer<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 3:** Reynold's Apparatus.<br>**Aim and Objectives:** To perform Reynold's experiment for determination of different types of flow.<br>**Outcomes:** Determination of Laminar, Transition & Turbulent flow.<br>**Theoretical Background:** Types of flow**.**<br>**Experimentation:** Calculation of Reynold's number with Interpretation.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 4:** Verification of Bernoulli's Equation.<br>**Aim and Objectives:** To verify Bernoulli's Equation.<br>**Outcomes:** Practical verification of Bernoulli's Equation.<br>**Theoretical Background:** Euler's Equation, Bernoulli's Equation & Assumptions.<br>**Experimentation:** Calculation & verification of Bernoulli's Equation.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 5:** Calibration of Venturimeter and Orificemeter.<br>**Aim and Objectives:** To calibrate Venturimeter and Orificemeter.<br>**Outcomes:** Calibration of Venturimeter and Orificemeter.<br>**Theoretical Background:** Discharge measurement by Venturimeter and Orificemeter.<br>**Experimentation:** Calculation of coefficient of discharge for Venturimeter and Orificemeter.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 6:** Calibration of Rectangular & Triangular notch.<br>**Aim and Objectives:** To calibrate Rectangular & Triangular notch.<br>**Outcomes:** Calibration of Rectangular & Triangular notch.<br>**Theoretical Background:** Discharge measurement by Rectangular & Triangular notch.<br>**Experimentation:** Calculation of coefficient of discharge for Rectangular & Triangular notch. | 02 Hrs |

| | |
|---|---|
| **Results and Discussions:**<br>**Conclusion:** | |
| **Experiment No. 7:** Orifice under steady & unsteady flow condition.<br>**Aim and Objectives:** To calculate hydraulic coefficients.<br>**Outcomes:** Study of steady & unsteady flow condition.<br>**Theoretical Background:** Definition & formula of hydraulic coefficients.<br>**Experimentation:** Calculation of hydraulic coefficients.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 8:** Determination of coefficient of friction in pipes of different materials.<br>**Aim and Objectives:** To determine coefficient of friction in pipes for different materials.<br>**Outcomes:** To calculate friction factor for different pipe material.<br>**Theoretical Background:** Derivation of coefficient of friction in pipes<br>**Experimentation:** Calculation for friction factor for different pipe material.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 9:** Determination of loss of friction in series pipes.<br>**Aim and Objectives:** To determine loss of friction in series pipes.<br>**Outcomes:** To calculate loss of friction in series pipes.<br>**Theoretical Background:** Derivation of head loss for major and minor losses.<br>**Experimentation:** Calculation of loss of friction in series pipes.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Experiment No. 10:** Determination of minor losses in pipe-fittings.<br>**Aim and Objectives:** To determine minor losses in pipe-fittings.<br>**Outcomes:** To estimate loss of head in pipe fittings such as sudden expansion, sudden contraction, bend & elbow.<br>**Theoretical Background:** Derivation of head loss for major and minor losses.<br>**Experimentation:** Calculation of loss of head in various pipe fittings.<br>**Results and Discussions:**<br>**Conclusion:** | 02 Hrs |
| **Textbooks:**<br>1. Dr. P.N. Modi and Dr. S.M. Seth, "Hydraulics and Fluid Mechanics including Hydraulic Machines", Standard Book House.<br>2. R.K.Bansal, "A Text book of Fluid Mechanics and Hydraulic Machines", Laxmi Publications Pvt. Ltd.New Delhi.<br>3. S. K.Som, Gautam Biswas, Suman Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines" Tata McGraw – Hill Publication.<br>4. Hydraulics Fluid Mechanics and Fluid Machines By S. Ramamrutham. | |
| **Reference Books:**<br>1. White, "Fluid Mechanics", McGraw Hill Publication.<br>2. Cengel Yunus A. And Cimbala John M. "Fluid Mechanics and Fundamental and applications", Tata Mcgraw-Hill New Delhi.<br>3. Streeter, Wylie and Bedford, "Fluid Mechanics", Tata McGraw – Hill Publication. | |
| **Experiment wise Measurable students Learning Outcomes:**<br>1. Able to calibrate instrument.<br>2. To estimate the discharge through a pipe or open channels. | |

| **Title of the Course: Workshop Practice II** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0334 | **--** | **--** | **1** | **2** |

**Course Pre-Requisite:** Nil

**Course Description:** Being a practice-oriented course, the present course focuses on practicing various skills useful for making different components/jobs using various workshop operations.

**Course Objectives:**

1. Acquire skills in basic engineering practice.
2. Perform sand testing
3. Perform different welding operations
4. Develop a mould for specific application.

**Course Outcomes:**

Students should be able to

2. ----

**Assessments :**

**Teacher Assessment:**

| Assessment | Marks |
|---|---|
| ISE 1 | 25 |

ISE is based on practical performed/ Quiz/ Presentation/ Group Discussion/Role plays/Assignments, etc

**Distribution:**

Term work shall consist of job along with workshop Diary completion.

Attendance and practical performance- 10

Workshop journal completion - 10

Industrial Visit attendance and Report -5

**Course Contents:**

| | |
|---|---|
| 1. Perform different sand testing<br>a) To find Size analysis and Grain fineness Number of moulding sand.<br>b) To calculate Hardness (mould/core) and Green Compressive strength of moulding sand<br>c) To find Permeability, Moisture percentage and Clay content of given sand | |
| 3. Job on welding process | |
| 4. From given component drawing, draw pattern layout, pattern drawing (with allowances included) and drawing of mould ready to pour with gating and rising. | |
| 5. Industrial visit report (Industrial visit to have practical knowledge of casting, forging, rolling and plastic forming etc.) | |

**Textbooks:**

4. P. N. Rao, *"Manufacturing Technology- Foundry, Forming and Welding",* Vol. I, Tata McGraw-Hill, N 3rd edition, 2009.

5. P. L. Jain, *"Principles of Foundry Technology",* Tata McGraw-Hill, New Delhi, 2nd Edition,2006.

6. P. C. Sharma, *"A Textbook of Production Technology (Manufacturing Processes)",* S. Chand & Company, 2006.

**References:**

1. O. P. Khanna, Foundry technology, Khanna Publishers, New Delhi.

2. Hajra Chowdhary, Elements of Workshop Technology, Vol. I, Media Promoters & Publications, Bombay

3. B.S. Raghuvanshi, Workshop Technology, Vol. II, Dhanapat Rai Publications, New Delhi, 10th Edition, 2000

# SY B TECH SEMESTER - IV

| **Title of the Course: Analysis of Mechanical Elements** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0401 | **3** | **1** | **0** | **4** |

**Course Pre-Requisite:** Engineering Mechanics

**Course Description:** This subject enables the student to understand the important concepts of stress and strain, their significance in concept with engineering applications and is useful while studying the Subjects like, Kinematics of Machines, Theory of machines, Dynamics of Machines.

**Course Objectives:**

1. To gain knowledge of different types of stresses, strains and deformation induced in Mechanical Components due to external loads.
2. To study the distribution of various stresses in Mechanical Elements.
3. To study the effect of component dimensions and shape on stresses and deformation.

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | **Bloom's Cognitive** | |
|---|---|---|---|
| | | **level** | **Descriptor** |
| **CO1** | **Find** stresses and deformations of different loads on structural members | 1 | Remembering |
| **CO2** | **Interpret** elastic behavior of structural members. | 2 | Understanding |
| **CO3** | **Construct** graphical solutions for given loading condition of structures. | 3 | Applying |
| **CO4** | **Analyze** stresses developed in oblique loading condition. | 4 | Analyzing |
| **CO5** | **Determine** the parameters of structural members under different loadings. | 5 | Evaluating |

**CO-PO Mapping:**

| **CO** | **a** | **b** | **C** | **d** | **e** | **f** | **g** | **H** | **i** | **j** | **k** | **l** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | |
| **CO2** | 2 | | | | | | | | | | | |
| **CO3** | | 3 | | | | | | | | | | |
| **CO4** | | | | 2 | | | | | | | | |
| **CO5** | | 2 | | | | | | | | | | |

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

| **Course Contents:** | |
|---|---|
| **Unit 1: Stresses and Strains**<br>Concept of stress and strain (linear, lateral, shear & volumetric),Hooke's Law, Elastic constants & their relationship, Axial force diagram, stresses, strains and deformation in determinate and indeterminate homogeneous and composite bars under concentrated loads, Various strengths of material- Yield strength, Ultimate tensile strength, etc. Factor of Safety. Normal and shear stresses, Complementary shear stress, Bulk modulus, interrelationship between elastic constants, thermal stresses. | **6 Hrs.** |
| **Unit 2: Torsion and Shear Force & Bending Moment**<br>**Torsion:** Theory of torsion of shafts of circular cross section, Assumptions, Derivation of torsion formulae.<br>**Shear Force & Bending Moment:** Concept and definition of shear force and Bending Moment in beams due to concentrated load, UDL, uniformly varying loads and couples in determinate beams, Maximum bending moment & positions of points of contra flexure. | **7 Hrs.** |
| **Unit 3: Bending Stresses and Shear Stress in Beams**<br>**Bending Stresses:** Theory of simple bending, Concept and assumptions, Derivation of flexure formula, Bending stresses distribution diagram, Moment of resistance and section modules calculations, design of rectangular and circular (solid and hollow) sections; L, I and T sections<br>**Shear Stress in Beams:** Concept and derivation of shear stress distribution formula, Shear stress distribution diagram for symmetrical and unsymmetrical section, maximum and average shear stress. | **8 Hrs.** |
| **Unit 4: Slope and Deflection of Beams**<br>Concept and definition, relation between Bending moment, slope and deflection, slope and deflection by double integration method (McCauley's method), Slope and Deflection in determinate beams by Moment Area method and conjugate beam Method | **6 Hrs.** |
| **Unit 5: Principal stresses and principal strain:**<br>Normal and shear stresses on any oblique planes and concept of principal planes, derivation of expression for principal stresses & maximum shear stress, position of principal planes & planes of maximum shear. Graphical solution using Mohr's circle of stresses, Theories of elastic failure **(**Maximum principal stress theory, maximum shear stress theory, maximum distortion energy theory, maximum strain theory – their applications & limitations) | **7 Hrs.** |
| **Unit 6: Columns and Strain energy**<br>**Columns:** Theory of columns – Long column and short column, Concept of critical load and buckling, Euler's formula for different end connections, concept of equivalent length, eccentric loading, limitations of Euler's formula, Rankine formula, Safe load on column.<br>**Strain energy:** Strain energy due to axial load (gradual, sudden and impact). Strain energy due to bending and torsion. | **6 Hrs.** |

**Term Work:** The term work shall consist of 6 assignments listed below.

1. Torsion
2. Shear force and bending moment diagram.
3. Bending and shear stresses in beams.
4. Deflection of beams
5. Principal stresses and theories of failures.
6. Columns.
7. Case study on structural analysis of assembly which includes applications of course contents.

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**Textbooks:**


1. S. Ramamrutham and R. Narayanan, (2003), Strength of Materials, Dhanpat Rai Publications.
2. S. Timoshenko, Strength of Materials: Part-I (Elementary Theory and Problems), CBS
3. Ferdinand P Beer and E.R. Johnston JR. John Dewolf, Mechanics of Materials 3/e, McGraw Hill Book Company
4. Mechanics of Materials Hibbler 2e Pearson Education Publication


**References:**


1. Robert Norton, Machine Design, Prentice Hall
2. E.P. Popov, "Introduction to Mechanics of solids", Prentice Hall Publication
3. Singer and Pytel, "Strength of Materials", Harper and Row Publications


**Unit wise Measurable students Learning Outcomes:**

1. Recognize basic concepts of stress, strain and their relations based on linear elasticity.
2. Calculate stresses and deformation of a torsional bar. Develop shear and bending moment diagrams.
3. Calculate bending and transverse shear stresses.
4. Analyze slope and deflections of beam under combined loads.
4. Apply concept of Mohr's circle to compute principal stresses and angles.
6. Predict stability and buckling for a slender member column under an axial compressive force.

| **Title of the Course: Machine Tools**<br>**Course Code:** UMCH0402 | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| | **3** | **1** | **--** | **4** |

**Course Pre-Requisite:** Operations performed on various machines

**Course Description:** This course aims to impart knowledge of machine tools and operations performed on to it, different movements required to process the component from raw material into finished product.

**Course Objectives:**

1)To understand the various conventional and basic machine tools and manufacturing processes carried out on these machines for different applications.
2) To gain the basic knowledge about machine tools and its construction and principles of working.
3) To study different parts of the machine tools used in manufacturing machine shops.
4) To study the detailed assembly of manufacturing machine tools.

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | **Bloom's Cognitive** | |
|---|---|---|---|
| | | **level** | **Descriptor** |
| **CO1** | The student shall be able to differentiate between metal cutting process and metal forming process. | 1 | Understanding |
| **CO2** | The student shall be able to use various systems of machine tool. | 2 | Applying |
| **CO3** | The student shall be able to identify machine tools for various operations performed on components. | 4 | Applying |
| **CO4** | The student shall be able to select machine tool or process for simple applications | 5 | Applying |

**CO-PO Mapping:**

| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | 1 | 1 | | 1 | 1 | 1 | 2 | | | | 1 | |
| **CO2** | 2 | | 2 | 1 | | 1 | 1 | 1 | 2 | | | | 1 | 2 |
| **CO3** | 2 | 2 | 2 | 1 | | 1 | 1 | 1 | | 1 | | | 2 | |
| **CO4** | 2 | 2 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | | 1 | | 2 |

**Assessments :**

**Teacher Assessment:√**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

| **Course Contents:** | |
|---|---|
| **Unit 1: Lathe, Capstan and Turret Lathe**<br>Working Principle, Specification, Principal Parts, Accessories , Attachments, Concept of speed, feed, depth of cut ,Operations, Numerical treatment of gear calculations, Principal Parts Capstan and Turret Lathe , Comparison Lathe , turret lathes & Capstan lathe, Tool holders, Turret Indexing Mechanism, Bar feeding Mechanism. | **8 Hrs** |
| **Unit 2: Drilling , Boring, Shaper, Planar**<br>Specification , Construction, working of Pillar type and Radial drilling Machine. Operations performed on drilling Machines. Specification, Construction, working of Vertical and Horizontal Boring Machine. Operations (Jig Boring) performed on boring machines. Boring tools and Bars. Working principle of Shaper ,Specification of Shapers, Principal Parts, Crank and Slotted link Mechanism, Circuit for Hydraulic Shaper, Table feed Mechanism. Working principle of Planar ,Specification of Planar, Principal Parts, Standard or double housing planar, Quick return Mechanism (Belt Drive) for planar tables, Feeding Mechanism (Ratchet and Pawl Mechanism), Planno- Miller and its Gear Box | **8 Hrs** |
| **Unit 3: Milling, Slotting, Broaching, Gear Manufacturing Processes**<br>Working principle, Up Milling and Down Milling, Specification of Milling Machine, Construction and Working Vertical Milling Machine , Construction and Working of Column and Knee type Milling Machine, Attachments (vertical milling attachment & Dividing Head) , Accessories, , Types of Milling Cutters, Operations performed. Principle of Broaching, Details of Broach Construction, Horizontal and Vertical Pull type broach, Continuous Broaching Machine, Pull Heads, Production Slotters, Principle of Gear Shaping & Gear Hobbing, Gear finishing processes- Gear shaving, Gear Burnishing, Gear rolling. | **8 Hrs** |

| | |
|---|---|
| **Unit 4: Grinding, Honing, Lapping, Burnishing**<br>Principle, Common wheel shapes, Method of specifying grinding wheels, Selection of Grinding wheels, Mounting of grinding wheels, Grinding Machine - Cylindrical grinder, centreless grinder, Surface grinder , Accessories (Sine table, Compound vice, Magnetic and Electromagnetic chuck) Loading and glazing of grinding wheels, Trueing and dressing the grinding wheels, wheel balancing, Honing, Lapping, Burnishing, | **6 Hrs** |
| **Unit 5: Advanced Manufacturing Technology /CNC Machines**<br>Classifications and Principle of CNC Machine ( Turning Centre, Vertical Machining Centre, Horizontal Machining Centre, Multi Axis Machining centre) ,<br><br>Turning Centre : Working of Machine Structure, Slideways, Spindle drive, Axis drive, Recirculating ball screw, Feedback devices(transducers, encoders), Multistation Turret ,Workholding- Chuck (3 Jaw,4 Jaw, Collet Chuck) Automatic Bar feeder, Hydraulic Tail stock, Part Catcher, Tool Holders<br><br>Vertical and Horizontal Machining Centre - Working of Machine Structure, Slideways, Spindle drive, Axis drive, Recirculating ball screw, Feedback devices(transducers, encoders), Automatic tool changer (ATC), Automatic pallet changer (APC), Various types of tools and Tool Adapters | **8 Hrs** |
| **Unit 6: Non Conventional Machine tools**<br>Fundamental principle, Machining unit, Tool Material, Advantage, Limitations and applications of Abrasive Jet Machining, Electrical Discharge Machining, Electro- chemical Machining, Laser beam Machining, Ultrasonic Machining, Water Jet Machining. | **4 Hrs** |

**Textbooks:**


- Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.
- B.S. Raghuwanshi, "Workshop Technology", Dhanpatrai Publication, 9th Edition, 1999.
- Rao, P.N., Manufacturing Technology–Metal Cutting and Machine Tools, Tata McGraw Hill, New Delhi, 2000.
- Hajra Chowdary, S.K., and Hajra Chowdary, A.K., Elements of Workshop Technology, Vol. II, Asia Publishing House, Bombay, 2003.
- Kalpakjian, S. and Steven R. Schmid, Manufacturing, Engineering & Technology, Pearson
- Production Technology by HMT, Tata McGraw-Hill, 2002
- Khanna, O.P., and Lal, M., A Text Book of Production Technology, Vol II , Dhanpat Rai & Sons, 1992.
- Fundamentals of metal cutting and Machine Tools, B.L. Juneja, G.S. Sekhon and Nitin Seth, New Age International Publishers 2nd Edition, 2003
- All about Machine Tools, Heinrich Gerling, New Age International Publishers revised 2nd Edition, 2006
- Fundamental of Machining and Machine Tools, Geoffrey Boothroyd and Winston A. Knight, CRC Taylor & Francis, Third Edition.
- Workshop Technology Vol. II by Bawa H. S. (TMH)


**References:**


1. Manufacturing Science – Amitabha Ghosh and Mallik, Affiliated East West press, 2010, 2nd edition.
2. Modern machining Process – Pandey and Shah, Tata Mc Graw Hill – 2009.
3. Manufacturing processes for Engineering Materials by Serope kalpakijian and Steven R.Schimid pearson education 2009, 5th edition.
4. Materials and Processes in Manufacturing by E.Paul DeGarmo, J T Black, Ronald A Kohser, 8th Edition, Prentice Hall of India Private limited, 2004.

| **Title of the Course: Kinematics of Machines** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0403 | **3** | **--** | **---** | **3** |

**Course Pre-Requisite:**

1. Engineering Mathematics 2. Engineering Physics 3. Engineering Mechanics

**Course Description:** Kinematics of Machines may be defined as that branch of Engineering-science, which deals with the study of relative motion between the various parts of a machine, and forces which act on them. The knowledge of this subject is very essential for an engineer in designing the various parts of a machine.

**Course Objectives:**

1. Define various terminology related to kinematics of mechanism
2. Develop competency in drawing velocity and acceleration diagram for simple and complex mechanism
3. Discuss effect of friction in various mechanism
4. Design cam with follower for different applications
5. Select different power transmitting elements

**Course Outcomes:**

Students should be able to

1. Explain kinematics of mechanisms.
2. Identify the mechanisms for various applications.
3. Apply the principles of kinematics to mechanisms.
4. Analyze mechanisms using graphical methods.

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE

**Course Contents:**

| | |
|---|---|
| **Unit 1:---Basic of Kinematics**<br>Structure, Machine, Link and its types, kinematic pair (lower and higher), Kinematic chain, Mechanism, inversion, Types of constraints, Grubbler‟s criterion, Inversions of slider crank chain, Double slider crank chain, Four bar | 05 **Hrs.** |
| **Unit 2:--- Velocity and acceleration analysis of Mechanisms**<br>Graphical analysis of Velocity and acceleration for different mechanisms using relative velocity and acceleration method, The coriolis component of acceleration, Velocity analysis by Instantaneous center method | 09 **Hrs.** |
| **Unit 3:---Friction**<br>Introduction of friction, Friction in pivot bearings, Friction in clutch, uniform wear and Uniform pressure for the clutch & bearing | 06 **Hrs.** |
| **Unit 4:---Cams**<br>Introduction, Types of cams, Types of followers, Cam terminology, Displacement diagrams, Motions of the follower, Graphical construction of cam profile. | 07 **Hrs.** |

| | |
|---|---|
| **Unit 5:--- Theory of Gears**<br>Classification of gears, Types of gears, Spur gears - terminology, fundamental law of toothed gearing, involute and cycloidal profile, conjugate action, contact ratio, minimum number of teeth, interference and under cutting. | 07 **Hrs.** |
| **Unit 6:--- Belts and Dynamometers**<br>Introduction, Type of belts, Slip and creep of belt, Tension ratio in belts, Initial tension, Open & cross belt drive, Length of belt, Power transmitted by belt, Classification of dynamometers, Study of rope brake absorption dynamometer and belt transmission dynamometer. | 06 **Hrs.** |

**Textbooks:**


1. Rattan, S.S.: "Theory of Machines", 2 nd Edition, Tata McGraw-Hill, Publishing Co. Ltd., New Delhi, 2006.
2. Bansal, R. K., "Theory of machines", Laxmi Publications Pvt. Ltd, New Delhi
3. Rao, J.S., and Dukkipati, R.V.: "Mechanism and Machine Theory", Wiley Eastern Ltd.
4. Ghosh, A, and Malick, A. K. "Theory of Mechanisms and Machines" 3 rd Edition, East West Press Pvt. Ltd., 2000.


**References:**


1. Shigley, J.E. and Uicker, J.J. and Pennock, G. R.. "Theory of Machines and Mechanisms", 3 rd Edition, Oxford University Press, 2005.
2. Bevan T., "Theory of Machines: a text book for engineering students", 3 rd Edition, CBS, New Delhi.


**Unit wise Measurable students Learning Outcomes:**

**1** Student will able to understand fundamental & various terminology associated with theory of machine

**2** Student will able to understand velocity and acceleration diagram for a given mechanism with graphical method.

**3** Student will able to understand laws of friction and Power loss due to friction in bearings & Clutches

**4** Student will able to understand different types of cams and followers and their motions and Construct different types of cam profile from given data

**5** Students will be able to solve and determine forces and dimensions of Spur Gear.

**6** Student will able to understand need and modes of power transmission and types of dynamometers

# Project Based Learning (PBL) of S.Y.B.Tech Sem II

**Course Name**: Kinematics of Machines (Lab)

**Course Code**:

Student can choose any one problem for Project Work out of four problems given below.

**Problem Statements:**

**KOMPBLPB01*: Design of Mechanism***

Identify any mechanism used in practice. Draw its kinematic diagram with scale. Determine its number of links, joints and degrees of freedom. Prepare working model of the same. Also prepare CATIA model of the same.

**KOMPBLPB02: Design of drive system**

Identify any practical power transmission system. Identify its elements. Prepare its working model. Calculate velocity ratio. Find actual dimensions of its elements. Also prepare CATIA model of the same.

**KOMPBLPB03: Design of cam**

Design cam operated mechanism for alternate sorting of items from conveyor. Prepare its working model. Also prepare CATIA model of the same.

**KOMPBLPB04: Analysis of power screw.**

Identify any power screw application. Prepare drawing of the same. Calculate screw parameters (type of threads, lead angle, pitch, etc.). Also prepare CATIA model of the same.

**2. Activities with timeline:**

| Sr. No. | Activity | Timeline |
|---|---|---|
| 1 | PBL awareness in class | 1st week |
| 2 | Announcement of problem/s for PBL | 2nd week |
| 3 | Team formation | 3rd week |
| 4 | Project ISE I:Synopsis presentation | 5th week |
| 5 | Completion of corrections/improvements in synopsis | 6th week |
| 6 | Project ISE II: Project Progress Presentation with Model/case study | 9th week |
| 7 | Completion of correction/improvements in Evaluation II | 10th week |
| 8 | End Semester Evaluation of Project | 12th week |
| 9 | Determining future scope for improvement | 14th week |

**3. Assessment Scheme:**

- ISE-I
- ISE-II
- Project ESE

**4. Evaluation Scheme:**

- **Project ISE I :** Synopsis presentation for 5 marks ( evaluation with rubrics)
- **Project ISE II:** Project Progress Presentation with Model/case study for 5 marks ( evaluation with rubric)
- **End Semester Evaluation of Project:** Multimedia presentation and demonstration of working models for 15 marks out of 25 of course lab ISE ( evaluation with rubrics)

| **Title of the Course: TURBOMACHINES** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0404 | **3** | **-** | **-** | **3** |

**Course Pre-Requisite: Fluid Mechanics, Steam Properties**

**Course Description:** The course deals with rotodynamic machines like water turbines, steam turbines, centrifugal pumps, centrifugal compressors etc,. The knowledge of these devices is necessary in all types of power plants.

**Course Learning Objectives:**

CLO1: To prepare students of Mechanical Engineering to excel in fundamentals of Turbomachinery to succeed in careers in industry, technical professions or entrepreneurship.

CLO2:To provide students with a solid foundation in Turbomachinery fundamentals required to solve engineering problems in thermal engineering and also to pursue higher studies.

CLO3:To train students with good scientific and engineering breadth in the areas of Turbomachinery, so as to comprehend, analyze, design and create novel products and solutions for the real life problems

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | Explain working principles and classification of turbomachines. | II | Understanding |
| **CO2** | Solve for design parameters of turbomachines at specified conditions. | III | Applying |
| **CO3** | Analyze the performance of turbomachines experimentally and analytically. | IV | Analyzing |
| **CO4** | Design the turbomachines for given specifications. | VI | Creating |

**CO-PO Mapping:**

| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** | **PSO3** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | | | | | | | 3 | | |
| **CO2** | 3 | 2 | | | | | | | | | | | | 3 | 2 |
| **CO3** | | 2 | | 3 | 3 | | | | | | | | | | |
| **CO4** | | | 3 | 2 | | | | | | | | | | 3 | |

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|

| | |
|---|---|
| ISE 1 | 10 |
| MSE | 30 |
| ISE 2 | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

**Course Contents:**

| | |
|---|---|
| **Unit 1: Introduction to Turbo Machines:**<br>Impulse momentum principle and its applications, Impact of jet on vanes.<br>**Impulse Water Turbines**<br>Pelton wheel: construction, principle of working, velocity diagrams and analysis, design aspects, governing and performance characteristics, specific speed, selection of turbines. | **07 Hrs.** |
| **Unit 2: Reaction Water Turbines:**<br>Classifications, Francis, Propeller, Kaplan Turbines, constructional features, velocity diagrams and analysis, Degree of Reaction, Daft tubes: types and analysis, Cavitation: causes and remedies. Specific speed, performance characteristics and governing of reaction turbines, selection of turbines. | **07 Hrs.** |
| **Unit 3: Steam Turbines:**<br>Steam nozzles: types and applications, Equation for velocity, mass flow rate, critical pressure ratio, effect of friction and condition for maximum discharge [No numerical treatment].<br>Steam Turbines: Classifications (Axial and Radial), construction details, compounding of steam turbines, velocity diagrams and analysis of Impulse and reaction steam turbines (single & multi stage), governing, performance characteristics. | **07 Hrs.** |
| **Unit 4: Centrifugal Pumps:**<br>Classification of rotodynamic pumps, components of centrifugal pump, types of heads, velocity triangles and their analysis, effect of outlet blade angle, cavitation, NPSH, MPSH(Maximum permissible Suction Head), Thoma's cavitation factor, priming of pumps, installation, specific speed, performance characteristics of centrifugal pump, series and parallel operation of pumps, selection of pumps. | **07 Hrs.** |
| **Unit 5: Centrifugal Compressor :**<br>Classification of rotodynamic compressors, blowers, fans. Centrifugal compressor: Construction, flow process on T-s Diagram, velocity diagram and Euler's work, slip factor and its effect on work input, actual work input, dimensionless parameters, pre-whirl losses, surging, choking, stalling characteristics. | **06 Hrs.** |
| **Unit 6: Axial Flow Compressor :**<br>Construction, stage velocity triangles and its analysis, enthalpy entropy diagram, dimensionless parameters, flow through the blade rows, pressure rise across the stage, stage losses and efficiencies, performance characteristics. | **06 Hrs.** |

**Textbooks:**


1. Energy Conversion Engineering Vol-III, Kadambi, Manohar Prasad
2. Principles of turbomachinery, D G Shepherd, Mc Millan, 1969.
3. Turbomachines, A Valan Arasu, Vikas Publishing.
4. A text book of Fluid Mechanics and Hydraulic Machines, R.K.Bansal, Laxmi

Publications

**References:**


1. Turbomachines, S.M.Yahya
2. Steam and Gas Turbines, R Yadav
3. Steam and Gas turbines, V Ganeshan
4. Steam turbine theory and practice, Kearton W J, Pitman
5. Hydraulic machines, V P Vasantdani.
6. Turbines, compressors, fans, S M Yahya, Tata McGraw Hill.


**Unit wise Measurable students Learning Outcomes:**

**1.** Graduates will be able to apply knowledge to solve step by step problems based on Impulse Turbine

**2.** Graduates will be able to draw and analyze velocity diagrams for Reaction Water Turbine

**3.** To analyze and solve problems on Centrifugal Pumps.

**4.** Graduates will demonstrate construction and working principle of Rotodynamic Air Compressor.

**5.** To analyze and solve problems on steam nozzle and impulse steam turbines.

**6.** To analyze and solve problems on reaction steam turbines.

| **Title of the Course: Metallurgy**<br>**Course Code:** UMCH0405 | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| | **3** | **-** | **-** | **3** |

**Course Pre-Requisite:** BME, Physics, Chemistry, Fundamental knowledge of materials and their basic properties

**Course Description:** Material selection is the important part for any component. To select the appropriate material, properties have to be determined. As well as to change the properties as per the requirement, knowledge of heat treatment is also necessary. Casting is integral part of manufacturing Industry so for that knowledge of cast iron and their related grades is also required.

**Course Objective**:

CO1:Explain various crystal structures and phases of metals and alloys

CO2:Explain equilibrium diagrams of ferrous and non ferrous metals

CO3:Explain the techniques used in manufacturing of PM components

CO4:Compare the heat treatment processes

CO5:Explain various destructive and nondestructive testing techniques

**Teachers Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISEI | 10 |
| MSE | 30 |
| ISEII | 10 |
| ESE | 50 |

ISE 1 and ISE 2 are based on assignment/declared test/Moodle quiz/Topic seminar/Group Discussions, Industrial case study etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

| **Unit 1: Introduction to Metals and alloy systems** | **7 Hrs** |
|---|---|
| Introduction to Metallic and Non-metallic materials and its classification (metals/alloys, polymers and composites)<br>a) Imperfections in crystals , Defects-Point, Line, Planar, Volume- Slip planes and slip systems<br>b) Alloy formation by crystallization, Nucleation and growth, Cooling curves, Dendritic structure and coring. c) Solid solutions and intermediate phases<br>d) Phases and Gibbs phase rule<br>e) Construction of equilibrium diagrams from cooling curves, Isomorphous | |

| | |
|---|---|
| system( Solid Solution), Eutectic, Partial solubility Peritectic and Intermetallic Compounds Lever arm principles, Long and short-range freezing | |
| **Unit 2:---** Ferrous alloys<br>With respect to typical compositions, Properties and Applications for the following alloys.)<br>a)Fe- Fe3C equilibrium diagram - Ferrous alloys (Plain carbon steels, cast iron)<br>b) Alloy steels- Free cutting steels, HSLA high carbon low alloy steels, maraging steels. creep resisting steels, Stainless steels- different types. Tool steels- types,<br>c) Selection of materials and Specifications based on -IS, BS, SAE, AISI,DIN,JIS<br>i) Miscellaneous alloys such as super alloys, Heating element alloys. Study of low expansion and controlled expansion alloys, Some Advanced Materials (shape memory alloys, glass ceramic, perovskite structure) | **9 Hrs.** |
| **Non Ferrous Alloys**<br>a) Copper based alloys brasses Cu- Zn, Bronzes Cu- Sn, , Cu- Be, Cu-Ni.<br>b) Aluminum based alloys Al- Cu(Duralumin),Precipitation Hardening, Al-Si (Modification),<br>c) Pb- Sn(Solders and fusible alloys),g)Sn-Sb alloys ( Babbits) ,h) Ti (Ti-6Al-4V)<br>d)Criteria for selection of materials for auto Industry aerospace, marine applications machine tools, refrigeration and air conditioning | **4 Hrs.** |
| **Unit 4:---Mechanical Testing**<br>a) Metallography<br>b) Destructive Testing methods: Tensile, Compressive, Impact, Fatigue, Creep, Hardness (Rockwell, Brinell and Vickers),<br>c) Non- Destructive Testing:Dye Penetrant, Magnetic, Ultrasonic, Radiography, Eddy Current testing. | **5 Hrs.** |
| Unit 5: **Principal of heat treatment and heat treatment of ferrous and non ferrous alloys**<br>a) Transformation of Pearlite into austenite upon heating,<br>b) Transformation of austenite into Pearlite, Bainite and Martensite on cooling.<br>c) TTT –Diagram and CCT - Diagrams - significance, Effect of alloying elements on TTT diagram and its significance.<br>d) Heat treatment furnaces and equipments, controlled atmosphere.<br>**Heat Treatment Processes:**<br>a) Heat Treatment of Steels<br>I. Annealing – Types-Full, Partial and Sub critical annealing (Various types) and purposes<br>II. Normalising- Purposes<br>III. Hardening (Hardening types), Purposes, Austempering and Martempering, Mechanism of quenching and Quenching media, Hardenability- Concept and methods of determination of hardenability- Grossmans critical diameter method and Jominy end quench test.<br>IV. Tempering Types, Structural transformations during tempering, purposes<br>sub zero treatment<br>Vc) Heat treatment defects and remedies | **12 Hrs.** |
| **Unit 6:---Surface Treatments**<br>I.Surface hardening - Flame and Induction<br>II. Chemical heat treatments for case hardening - Carburising, Nitriding, Cyaniding, Carbonitriding<br>III. Phosphating, Graphite coating, Tin plating, Hard Anodising, Screen Printing with Molybdnum Sulphide, Zinc plating | **4Hrs.** |

**Textbooks:**

1 S.H. Avner, “Introduction to physical metallurgy”, Mcgraw Hill Book Company Inc, Edition, 2nd, 1974.
2 Vijendrasingh, “Physical metallurgy”, Standard Publishers Delhi
3. W. D Callister, “Material science and engineering”, Wiley India Pvt. Ltd., 5th Edition.
4. V.D. Kodgire, “Material science and metallurgy for engineers”, Everest Publishers Pune,12th Edition
5. T.V. Rajan / C.P. Sharma, “Heat Treatments Principles and Practices”, Prentice Hall of India Pvt Ltd, New Delhi
6. V Raghwan, “Material Science and Engineering”, Prentice Hall of India Pvt. Ltd., New Delhi ,3rd Edition, 1995.
7. Kenneth G. Budinski, “Surface Engineering for wear resistance”, Prentice Hall of India

**References:**

1] 1.V. Raghvan, “Materials Science & Engineering”, PHI 5th Edition, Prentice-Hall of India (P) Ltd.
2. W. Callister, “Materials Science & Engineering”, John Wiley & sons
3. References: 1 R.A. Higgins, “Engineering Metallurgy”, Viva Books Pvt. Ltd., New Delhi, 1 st Edition
5. ASM Handbook Volume no.5 Surface Engineering

**Unit wise measurable learning outcomes**

After the completion of course the student should be able to
CO1:Explain various crystal structures and phases of metals and alloys
CO2:Explain equilibrium diagrams of ferrous and non ferrous metals
CO3:Explain the techniques used in manufacturing of PM components
CO4:Compare the heat treatment processes
CO5:Explain various destructive and nondestructive testing techniques

| **Class:** S.Y.B.Tech Environmental Engineering | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Title of the Course:** Audit Course – I: Environmental Studies | 2 | - | - | Audit Course |
| **Course Code:** UMCH461 | | | | |

**Course Pre-Requisite:**

Students shall have knowledge of:

- Science
- Technology

**Course Description:**

The objective of the course is imparting fundamental knowledge and awareness of Environmental science among students *and importance of conservation of environment.*

**Course Objectives:**

At the end of the course students will be able to

1. Study scope and importance of natural resources, ecosystems, biodiversity for creating awareness and their conservation in multiple disciplines.
2. Learn various types of pollution, their impacts and control measures for minimizing pollution and sustainable development.
3. Understand social issues related environment, environmental ethics and human rights towards environment.
4. Study various laws & regulations related to environment and its applicability in society and industries.
5. Choose one of the sectors of environment for detail study as project.

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | **Bloom's Descriptor** |
|---|---|---|
| CO1 | Describe natural resources, importance of ecosystem & conservation of biodiversity with respect to multiple disciplines. | Cognitive |
| CO2 | Explain causes, effects, solutions for various pollution problems and its minimization strategies. | Cognitive |
| CO3 | Discuss environmental ethics & their implementation for betterment of environment & human life. | Cognitive |
| CO4 | Differentiate between requirements of laws & regulations for environmental conservation and applicability of legislations in society and industries. | Cognitive |
| CO5 | Prepare detailed project report on selected topic based on environmental issues/problems. | Cognitive |

**CO-PO Mapping:**

| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | 2 | | | | | |
| CO2 | 3 | | | | | | | | | | | |
| CO3 | | | | | | | | 2 | | | | |
| CO4 | | | | | | 2 | | | | | | |
| CO5 | | | | | | | | | | 2 | | |

**Assessments :**

| **Assessment** | **Weightage (Marks)** |
|---|---|

| ESE | 50 |
|---|---|

**ESE:** Assessment is based on 100% course content.

**Course Contents:**

| | |
|---|---|
| **Module 1:Nature of Environmental Studies**<br>Definition, scope and importance, Multidisciplinary nature of environmental studies, Need for public awareness. | **4 Hours** |
| **Module 2: Natural Resources and Associated Problems**<br>a) Forest resources: Use and over-exploitation, deforestation, dams and their effects on forests and tribal people.<br>b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems.<br>c) Mineral resources: Usage and exploitation. Environmental effects of extracting and using mineral resources.<br>d) Food resources: World food problem, changes caused by agriculture effect of modern agriculture, fertilizer-pesticide problems.<br>e) Energy resources: Growing energy needs, renewable and nonrenewable energy resources, use of alternate energy sources.<br>Solar energy, Biomass energy, Nuclear energy.<br>f) Land resources: Solar energy , Biomass energy, Nuclear energy, Land as a resource, land degradation, man induced landslides, soil erosion and desertification.<br>Role of an individuals in conservation of natural resources. | **4 Hours** |
| **Module 3: Ecosystems**<br>Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers. Energy flow in the ecosystem, Ecological succession.<br>Food chains, food webs and ecological pyramids.<br>Introduction, types, characteristics features, structure and function of the following ecosystem :-<br>a) Forest ecosystem, b) Grassland ecosystem, c) Desert ecosystem, d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). | **6 Hours** |
| **Module 4:Biodiversity and its conservation**<br>Introduction- Definition: genetic, species and ecosystem diversity.<br>Bio-geographical classification of India.<br>Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.<br>India as a mega- diversity nation, Western Ghat as a biodiversity region.<br>Hot-spot of biodiversity. Threats to biodiversity habitat loss, poaching of wildlife, man-wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. | **6 Hours** |
| **Module 5:Environmental Pollution**<br>Definition: Causes, effects and control measures of: Air pollution, Water pollution, soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards. Solid waste Management: Causes, effects and control measures of urban and industrial wastes. Role of a individual in prevention of pollution. | **6 Hours** |
| **Module 6: Social Issues and the Environment**<br>Disaster management: floods, earthquake, cyclone, tsunami and landslides. Urban problems related to energy Water conservation, rain water harvesting, watershed | **8 Hours** |

| | |
|---|---|
| management, Resettlement and rehabilitation of people; its problems and concerns.<br>Environmental ethics: Issue and possible solutions. Global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation.<br>Consumerism and waste products. | |
| **Module 7:Environmental Protection**<br>From Unsustainable to Sustainable development.<br>Environmental Protection Act.<br>Air (Prevention and Control of Pollution) Act.<br>Water (Prevention and control of Pollution) Act.<br>Wildlife Protection Act.<br>Forest Conservation Act.<br>Population Growth and Human Health, Human Rights. | **8 Hours** |

**Textbooks:**

1. Environmental Studies by Dr. P.D.Raut (Shivaji University, Kolhapur)

**References:**


1. Miller T.G. Jr., Environmental Science. Wadsworth Publications Co.(TB).
2. Odum, E.P.1971, Fundamentals of Ecology, W.B.Saunders Co. USA,574p
3. Trivedi R.K. Handbook of Environmental Laws, Rules, Guidelines,Compliances and Standards, vol. I and II, Environmental Media (R)


**Unit wise Learning Outcomes:**

At the end of the course the students will be able to

| | |
|---|---|
| UO 1 | Describe scope and importance of environmental studies. |
| UO 2 | Describe types of natural resources, their use and conservation. |
| UO 3 | Explain structure and functions of ecosystem, their types and importance. |
| UO 4 | Discuss biodiversity, endangered species and methods of biodiversity conservation. |
| UO 5 | Explain causes, effects and solutions to pollution problems. |
| UO 6 | Discuss environmental ethics and various social issues related to environment. |
| UO 7 | Discuss laws and regulations for conservation of environment. |

| **Title of the Course: Workshop Practice III**<br>**Course Code:** UMCH0431 | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| | | | **2** | **1** |

**Course Pre-Requisite:** Machine Drawing Fundamentals, Manufacturing Process, Machine Tools, Operations performed on various machines

**Course Description:** .This course is designed to provide the students with hands on knowledge and the practical learning experience on various machine tools and operations on it.

**Course Objectives:**
To practice basic metal cutting processes and acquire elementary skills.

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | **Bloom's Cognitive** | |
|---|---|---|---|
| | | **level** | **Descriptor** |
| **CO1** | Explain the fundamentals of metal removal process | 2 | |
| **CO2** | Explain construction and working of conventional machine tools | 2 | |
| **CO3** | Plan the sequence of operations required | 3 | |
| **C04** | Perform various machining operations. | 5 | |

**CO-PO Mapping:**

| **CO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 1 | | | | | | | | | | | | | |
| **CO2** | | 2 | | | | | | | | | | | | |
| **CO3** | | | | 2 | | | | | | | | | | |
| **CO4** | | | | | | 2 | | 2 | | | | 2 | | 3 |

**Assessments :**
**Teacher Assessment:**

| Assessment | Marks |
|---|---|
| ISE | 25 |
| ESE( POE) | 25 |

ISE: Assessment is based on 100% lab work.
ESE(POE): Assessment is based on 100% job performed and oral conducted.

| **Course Contents:** | |
|---|---|

| | |
|---|---|
| Introduction to basic operations and tools | 2 hrs |
| Reading the component Drawing, selecting and preparing operation sequence | 2 hrs |
| Manufacturing of component on lathe, Milling and Drilling Machine. Job consists of operations such as turning, facing, grooving, Taper turning, Threading, Knurling, centre drilling etc. | 14 hrs |
| Demonstration of Surface grinder , Cylindrical grinder followed by assignment | 2 hrs |
| Demonstration of wheel truing , dressing on grinding wheels followed by assignment | 2 hrs |
| Demonstration of adjusting stroke on shaper/ Planer Machine followed by assignment | 2 hrs |
| Demonstration of Turning Centre followed by assignment | 4 hrs |
| **Note:-**<br>• Students should prepare setup wise working drawing showing all the details in work diary/operation sheet.<br>• Dimensional accuracy is of prime importance.<br>• Student must maintain work diary/operation sheet showing regular progress in the semester.<br>• The practical oral examination(POE) shall include manufacturing of one assigned job & its operation on lathe machine followed by an oral examination.<br>**Textbooks:**<br>1. Workshop Technology Vol. I & II by Hajra Chaudhary, (Media Promoters & Publishers Pvt. Ltd.)<br>2. Workshop Technology Vol. I , II and III by W.A.J. Chapman, ( ELBS )<br>3. Workshop Technology Vol. II by Bawa H. S. (TMH)<br>4. A Course on Workshop Technology – Vol. 1 by B. S. Raghuvanshi; (Dhanpat Rai & Co.)<br>5. Workshop Technology Vol. III – Chapman (ELBS) | |

| **Title of the Course: Kinematics of Machines Lab** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0432 | **--** | **--** | **2** | **1** |

**Course Pre-Requisite:**

1. Engineering Mathematics 2. Engineering Physics 3. Engineering Mechanics

**Course Description:** Kinematics of Machines may be defined as that branch of Engineering-science, which deals with the study of relative motion between the various parts of a machine, and forces which act on them. The knowledge of this subject is very essential for an engineer in designing the various parts of a machine.

**Course Objectives:**

1. Define various terminology related to kinematics of mechanism
2. Develop competency in drawing velocity and acceleration diagram for simple and complex mechanism
3. Discuss effect of friction in various mechanism
4. Design cam with follower for different applications
5. Select different power transmitting elements

**Course Outcomes:**

Students should be able to

5. Explain kinematics of mechanisms.
6. Identify the mechanisms for various applications.
7. Apply the principles of kinematics to mechanisms.
8. Analyze mechanisms using graphical methods.

**Assessments :**

**Teacher Assessment:**

One component of In Semester Evaluation (ISE)

| Assessment | Marks |
|---|---|
| ISE | 25 |

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

**Course Contents:**

| | |
|---|---|
| **Experiment No. 1:---**Study of Basic of Kinematics<br>**Aim and Objectives:** To study basic concept of kinematics and verify the different laws related to mechanisms<br>Case Study on Basic of Kinematics<br>**Outcomes:** Students should be able to understand different types of mechanisms and their applications<br>**Theoretical Background:** Basic of Kinematics | 02 **Hrs.** |
| **Experiment No. 2:-**Verification of ratio of angular velocities of shafts connected by Hooke's joint<br>**Aim and Objectives:** To study the theory of Hooke's joint and to verify the of angular velocities of driving and driven shafts using model<br>**Outcomes:** Students should be able to understand the Hooke's joint<br>**Theoretical Background:** Theory of Hooke's joint<br>**Experimentation:** Calculation of ratio of angular velocities of driving and driven shafts using model<br>**Results and Discussions:** Compare Analytical & Experimental ratio of angular velocities of driving and driven shafts<br>**Conclusion:** Drawn conclusion at what value of Θ the ratio of angular velocities of driving and driven shafts is maximum, minimum & unity | 02 **Hrs.** |

| | |
|---|---|
| **Experiment No. 3:---**Velocity & Acceleration analysis of mechanisms by Relative Velocity Method<br>**Aim and Objectives:** To study basic theory and analysis of velocity & Acceleration in mechanism<br>**Outcomes:** Analyze velocity and acceleration of mechanisms by vector and graphical methods<br>**Theoretical Background:** Velocity and acceleration analysis of Mechanisms<br>To draw velocity and acceleration diagram for a simple mechanism and coriolis component acceleration. | 04 **Hrs.** |
| **Experiment No. 4:---** Velocity analysis of mechanisms by instantaneous centre method.<br>**Aim and Objectives:** To study basic theory and analysis of velocity by instantaneous centre method.<br>**Outcomes:** Analyze velocity by instantaneous centre method<br>**Theoretical Background:** Velocity analysis by instantaneous centre method.<br>To draw velocity diagram using instantaneous centre method | 02 **Hrs.** |
| **Experiment No. 5:---** Construction of cam profile by considering different follower motion<br>**Aim and Objectives:** To study basic of cam & follower and Construct different types of cam profile from given data<br>**Outcomes:** Students should be able to design cam with follower for different applications<br>**Theoretical Background:** Cams-To draw the layout of cam profile for different follower by considering different follower motion | 02 **Hrs.** |
| **Experiment No. 6:---** Sleep & Creep of Belts<br>**Aim and Objectives:** To study the sleep & creep of belts<br>**Outcomes:** Students should be able to understand sleep & creep of belts<br>**Theoretical Background:** Theory of Belt Drive<br>**Experimentation:** Calculation of percentage of sleep and creep using apparatus<br>**Results and Discussions:** Compare Sleep & Creep percentage for different load<br>**Conclusion:** Find out effect of sleep and creep on belt drive | 02 **Hrs.** |
| **Experiment No. 7:---** Study of Rope Brake Dynamometer<br>**Aim and Objectives:** To conduct load test on rope brake using an electrical motor and to find efficiency of the motor<br>**Outcomes:** Students should be able to understand construction and working of rope brake dynamometer<br>**Theoretical Background:** Theory of dynamometer<br>**Experimentation:** Calculation of input power, output power and mechanical efficiency<br>**Results and Discussions:** Compare efficiency of motor for different load<br>**Conclusion:** Find out effect of load on efficiency of the motor | 02 **Hrs.** |
| **Experiment No. 8:---** Study of governor characteristics of porter governor<br>**Aim and Objectives:** To study types & working of various governors & characteristics of porter governor<br>**Outcomes:** Students should be able to understand types & working of various governors & characteristics of porter governor<br>**Theoretical Background:** Theory of governor<br>**Experimentation:** Calculation of height, angle, controlling force, centrifugal force, mean force of porter governor<br>**Results and Discussions:** Compare the result for different speed<br>**Conclusion:** write the conclusion about stability of porter governor | 02 **Hrs.** |

**Textbooks:**


5. Rattan, S.S.: "Theory of Machines", 2 nd Edition, Tata McGraw-Hill, Publishing Co. Ltd., New Delhi, 2006.
6. Bansal, R. K., "Theory of machines", Laxmi Publications Pvt. Ltd, New Delhi
7. Rao, J.S., and Dukkipati, R.V.: "Mechanism and Machine Theory", Wiley Eastern Ltd.
8. Ghosh, A, and Malick, A. K. "Theory of Mechanisms and Machines" 3 rd Edition, East West Press Pvt. Ltd., 2000.


**References:**


3. Shigley, J.E. and Uicker, J.J. and Pennock, G. R.. "Theory of Machines and Mechanisms", 3 rd Edition, Oxford University Press, 2005.
4. Bevan T., "Theory of Machines: a text book for engineering students", 3 rd Edition, CBS, New Delhi.


**Experiment wise Measurable students Learning Outcomes:**

**1** Students should be able to understand different types of mechanisms and their applications
**2** Students should be able to understand the Hooke's joint
**3** Analyze velocity and acceleration of mechanisms by vector and graphical methods
**4** Analyze velocity by instantaneous centre method
**5** Students should be able to design cam with follower for different applications
**6** Students should be able to understand sleep & creep of belts
**7** Students should be able to understand construction and working of rope brake dynamometer
**8** Students should be able to understand types & working of various governors & characteristics of porter governor

| Title of the Course: TURBOMACHINES LAB | L | T | P | Credit |
|---|---|---|---|---|
| **Course Code:** UMCH0433 | - | - | 2 | 1 |

**Course Pre-Requisite: Fluid Mechanics**

**Course Description:**

**The course aims at experimentation on turbo machines like Pelton wheel, Francis turbine etc,.**

**Course Learning Objectives:**

CLO1: To provide the students the fundamentals and working principles of pumps, compressors and turbines.

CLO2:To train students with good scientific and engineering breadth in the areas of Turbomachinery, so as to comprehend, analyze, design and create novel products and solutions for the real life problems

**Course Learning Outcomes:**

| CO | After the completion of the course the student should be able to | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | Explain working principles and classifications of turbomachines | II | Understanding |
| **CO2** | Analyze the performance of turbomachines experimentally and analytically. | IV | Analyzing |

**CO-PO Mapping:**

| CO | PO1 | PO2 | PO3 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | | | | 3 | | |
| **CO2** | | 2 | | | 3 | | | | | | | | | | 2 | 1 |

**Assessments :**

**Teacher Assessment:**

One component of In Semester Evaluation (ISE)

| Assessment | Marks |
|---|---|
| ISE | 25 |

ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.

**Course Contents:**

| | |
|---|---|
| **Experiment No. 1: Trial on Pelton wheel turbine.**<br>**Aim and Objectives:** To determine hydraulic, mechanical and overall efficiency of Pelton Wheel<br>**Outcomes:** The students will be able to understand the performance of Pelton wheel. | **02Hrs** |
| **Experiment No. 2: Trial on Francis turbine**<br>**Aim and Objectives:** To determine overall efficiency of Francis Turbine<br>**Outcomes:** The students will be able to understand the performance of Francis | **02 Hrs** |

| | |
|---|---|
| turbine. | |
| **Experiment No. 3: Trial on Centrifugal pump**<br>**Aim and Objectives:** To determine overall efficiency of Centrifugal pump<br>**Outcomes:** The students will be able to understand the performance of Centrifugal pump. | **02 Hrs** |
| **Experiment No. 4: Trial on Centrifugal blower**<br>**Aim and Objectives:** To determine overall efficiency of Centrifugal blower<br>**Outcomes:** The students will be able to understand the performance of Centrifugal blower. | **02 Hrs** |
| **Experiment No. 5: Study and demonstration of steam turbines**<br>**Aim and Objectives:** To study and demonstrate the working principle of steam turbine<br>**Outcomes:** The students will be able to understand and demonstrate the working principles of steam turbines. | **02 Hrs** |
| **Experiment No. 6: Study and demonstration of various pumps like Gear pump, submersible pump , reciprocating pump etc,.**<br>**Outcomes:** To explain the working principle of various pumps like Gear pump, submersible pump , reciprocating pump etc,. | **02 Hrs** |

**Textbooks:**

5. Energy Conversion Engineering Vol-III, Kadambi, Manohar Prasad
6. Principles of turbomachinery, D G Shepherd, Mc Millan, 1969.
7. Turbomachines, A Valan Arasu, Vikas Publishing.
8. A text book of Fluid Mechanics and Hydraulic Machines, R.K.Bansal, Laxmi Publications

**References:**

7. Turbomachines, S.M.Yahya
8. Steam and Gas Turbines, R Yadav
9. Steam and Gas turbines, V Ganeshan
10. Steam turbine theory and practice, Kearton W J, Pitman
11. Hydraulic machines, V P Vasantdani.
12. Turbines, compressors, fans, S M Yahya, Tata McGraw Hill.

**Experiment wise Measurable students Learning Outcomes: At the end of each experiment the students will be able to**

1. Plot characteristics of Pelton wheel
2. Plot characteristics of Francis turbine
3. Plot characteristics of Centrifugal pump
4. Plot characteristics of Centrifugal blower
5. Demonstrate the working principle of steam turbines
6. Demonstrate the working principle of various pumps.

| Title of the Course: Computer Graphics Lab | L | T | P | Credit |
|---|---|---|---|---|
| Course Code: UMCH0434 | - | - | 2 | 1 |

**Course Pre-Requisite: Basics of C Language programming, Engineering Graphics.**

**Course Description:**

**Course Objectives:**

1) To introduce student about computer graphics leading to the ability to understand contemporary
2) To study basic concepts of computer graphics techniques, focusing on 3D modeling, Image synthesis
3) To study physical significance of Curves and Surfaces
4) To study need for hidden surface removal.

**Course Learning Outcomes:**

| CO | After the completion of the course the student should be able to | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | To **Acquire** the knowledge of basics of computer graphics. | 1 | Cognitive (Knowledge) |
| **CO2** | To **Apply** basic programming in C for line, rectangle, circle etc for different shapes. | 1 | Cognitive (Knowledge) |
| **CO3** | To **recognize** the importance of using three dimensional transformations like translation, scaling and rotating. | 1 | Cognitive (Knowledge) |
| **CO4** | To **Analyzing** the hidden unwanted parts in graphics and do the program on animation. | 2 | Psychomotor (Skill) |
| **CO5** | To **choose** the different of curves and surfaces while drawing CAD models. | 2 | Psychomotor (Skill) |

**CO-PO Mapping:**

| PO | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | √ | | | | | | | | | | |
| **CO2** | | | √ | | | | | | | | | |
| **CO3** | | | | | | | √ | | | | | |
| **CO4** | | √ | | | | | | | | | | |
| **CO4** | | | | | | √ | | | | | | |
| **CO5** | | | | | | | | √ | | | | |
| **CO6** | | | | √ | | | | | | | | |

**Assessments :**

**Teacher Assessment:**

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one EndSemester Examination (ESE) having 20%, 30% and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE | 25 |
| ESE(POE) | 25 |

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar/Group Discussions etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content

| | |
|---|---|
| (normally last three modules) covered after MSE. | |
| **Course Contents:** | |
| **Unit 1:-** Introduction and background of Computer Graphics, Need of Computer Graphics, Importance of Computer Graphics in the area of CAD/CAM/CAE,<br>Display devices: Refresh Cathode ray Tubes, Random Scan and Raster Scan monitors, Colour CRT Monitors, Direct view Storage Tubes, Continuous Refresh and Storage display, LED and LCD Monitors. | **(07)Hrs.** |
| **Unit 2:- Graphic primitives:** Points & Lines, Line drawing Algorithm, DDA and Bresenham's Algorithm. Fill Algorithm: Scan-Line Polygon Fill algorithm, Boundary Fill Algorithm, Flood Fill Algorithm, Seed fill algorithm. Attributes of primitives: Line style, Type, Width, Colour, Character Attributes, Area Filling. | **(07)Hrs.** |
| **Unit 3:-**<br>Analytical & Synthetic curve: C0, C1 & C2 Continuity, Convex hull, Parametric & non parametric representation of curves. Analytic curves: Circle, Ellipse, Parabola, Hyperbola, Splines: linear, quadratic, cubic, hermite, Bezier curves, Synthetic Curves: Circle and ellipse drawing, Parametric and Breshenham's algorithm. | **(07)Hrs.** |
| **Unit 4:-** 2D Transformation: Basic transformation- Translation, Scaling, Rotation, Reflection, Twist, Matrix Representation, Composite Transformations.<br>3D Transformation: Basic Transformations, 3D Display parallel & perspective projection. | **(04) Hrs.** |
| **Unit 5:-** Viewing: Viewing world co-ordination system, Normalized co-ordinate system, Device/Image co-ordination system, Window definitions, View port definitions, Viewing transformation.<br>Clipping: Point clipping, Line clipping, Cohen- Sutherland clipping, Midpoint clipping method, Sutherland and Hodgeman Clipping. | **(05) Hrs.** |
| **Lab Work :** All the algorithms are to be practiced in the computer Programming Laboratory using suitable programming language | |
| **Textbooks:**<br>1. Computer Graphics-Donald hearn and M.Pauline Baker-Prentice Hall of India Pvt Ltd.<br>2. Introduction to Computer Graphics – N. Krishnamurhy - TMH Publication. | |
| **References:**<br>1. Computer Graphics –Harrington S. – TMH Publication.<br>2. Computer Graphics - Schaum's Outline –TMH Publication | |

| **Title of the Course: Metallurgy Lab** | **L** | **T** | **P** | **Credit** |
|---|---|---|---|---|
| **Course Code:** UMCH0435 | -- | - | 2 | 1 |

**Course Pre-Requisite: BME,Physics,Chemistry**

**Course Description:**

Material selection is the important part for any component. To select the appropriate material properties have to be determined. As well as to change the properties as per the requirement knowledge of heat treatment is also necessary. Also by identifying microstructures one can determine the phases and composition

**Course Objective:**

CO1: To describe solidification behavior of the material and predict their microstructure
CO2: To determine different properties like strength, elongation, toughness, hardness by doing tests like Tensile test, Impact test, Hardness test.
CO3:To study different NDT techniques for determining surface and sub surface cracks
CO4:To study various heat treatment processes and their micro structural changes.
CO5: To study the concept of hardenability

**Course Learning Outcomes:**

| **CO** | **After the completion of the course the student should be able to** | Bloom's Cognitive level | Descriptor |
|---|---|---|---|
| **CO1** | To describe solidification behavior of the material and predict their microstructure | I | Knowledge |
| **CO2** | To determine different properties like strength, elongation, toughness, hardness by doing tests like Tensile test, Impact test, Hardness test. | II | Knowledge |
| **CO3** | To choose different NDT techniques for determining surface and sub surface cracks | II | Knowledge |
| **CO4** | To explain various heat treatment processes and their micro structural changes | II | Knowledge |
| **CO5** | To explain the concept of hardenability | II | Knowledge |

**CO-PO Mapping:**

| **CO** | **a** | **b** | **c** | **d** | **e** | **f** | **g** | **h** | **i** | **j** | **k** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | | | | | | | | | | |
| **CO2** | 3 | | | | | | | | | | |
| **CO3** | 2 | | | | | | | | | | |
| **CO4** | 2 | | | | | | | | | | |
| **CO4** | 2 | 3 | | | | | | | | | |
| **CO5** | 2 | | | | | | | | | | |

**Assessments :**

**Teacher Assessment:**

One component of In Semester Evaluation (ISE) and one End Semester Examination (ESE) having 50%, and 50% weights respectively.

| Assessment | Marks |
|---|---|
| ISE | 50 |
| ESE | 50 |

| | |
|---|---|
| ISE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.<br>ESE: Assessment is based on oral examination | |
| **Course Contents:** | |
| **Experiment No. 1:--Study Metallurgical Microscope**<br>**Aim and Objectives:** To study the construction and working of metallurgical microscope<br>**Outcomes:** The student should be able to explain the working and construction of metallurgical microscope | 2- **Hrs.** |
| **Experiment No. 2:--- Tensile testing of M.S. and CI**<br>**Aim:** To determine the properties like elongation, tensile strength, breaking stress, percentage reduction in area on steel and cast iron sample.<br>**Outcome**: By determining the properties like strength, toughness and ductility he is able to select the appropriate material<br>**Theoretical background:** Stress, strain calculation<br>**Experimentation:** Marking gauge length according IS standards. Applying load gradually under tensile loading conditions under the material breaks<br>**Results and discussion**: Tensile strength, ductility, yield point, breaking stress<br>**Conclusion**: The material is ductile /brittle | 4- **Hrs.** |
| **Experiment No.3 – Hardness Testing (Rockwell and Brinell)**<br>**Aim:** To determine the hardness of given material also relation between hardness and other mechanical properties**.**<br>**Outcome :** At the end of the experiment the student should be able to find out hardness number of given material.<br>**Theoretical background:** Procedure for operating the Brinell Hardness testing Machine and Rockwell Hardness Testing Machine and Hardness number calculation<br>**Experimentation:** To operate the hardness testing machine to determine hardness number.<br>**Results and Discussion:Hardness** Number | 2 Hrs. |
| **Experiment No. 4:-- Impact testing(Izod and Charpy) of M.S, Brass and Al Alloy**<br>**Aim:** To determine toughness under impact loading conditions.<br>**Outcome**: The student should be able to determine Toughness value under impact loading conditions.<br>**Theoretical background:** Toughness under impact loading condtions, DBTT<br>**Experimentation:** Material is prepared according to Izod and Charpy specifications. It is placed on impact testing machine and energy required to break the specimen is calculated.<br>**Results and Discussion**: Toughness value for different material and type of break<br>**Conclusion:** Ductile material behave differently in different conditions | 2- **Hrs.** |
| **Experiment No. 5:--- Demonstration of N.D.T. (Minimum two of different NDT tests**<br>**Aim:** To determine surface and subsurface cracks.<br>**Outcome**: The student should be able to use different NDT methods.<br>**Experimentation**: Dye penetrant test :cleaning,penetrant application and developer application<br>**Results and Discussion**: Material is having crack and also location can also be found out. | 2 **Hrs.** |

| | |
|---|---|
| **Experiment No. 6:--- Preparation of sample by metallography and examination of microstructure of steels and Cast Irons**<br>**Aim:** Prepare the sample by metallography and identify phases and their percentages.<br>**Outcome**: Students should able to prepare Metallography samples for Micro structural analysis and Identify phases.<br>**Theoretical background** : Iron iron carbide diagram and their phases<br>**Experimentation**: Metallography and use of microscope<br>**Result and discussion:** Identification of phases and their relative percentages and their relation with carbon %<br>**Conclusion:** The carbon % of given sample is ---------- | 4**Hrs.** |
| **Experiment No.7:--- Examination of microstructure of Non ferrousalloys (Brass, Duralimin, Babbit)**<br>**Aim:** To identify phases of the given non ferrous sample.<br>**Outcome:**At the end of the experiment the student should be able to find out phases in the non ferrous sample and their relation with the properties<br>**Theoretical Background:** Knowledge of non ferrous alloys and their phases**.**<br>**Experimentation:**To observe the sample under microscope | 2 **Hrs.** |
| **Experiment No.8- Heat treatment of steels (Annealing, Normalizing, Hardening on medium/ high carbon steels**)<br>**Aim:** To observe various heat treatment processes.<br>**Outcome**: At the end of the experiment the students should able to understand effect of heat treatment on mechanical properties of metals.<br>**Experiment**: To heat the sample to require temperature and carry out heat treatment processes. | 2 Hrs |
| **Experiment No.9 - Jominy end quench test for hardenability**<br>Aim: To determine effect of quenching media, rate of cooling on hardness number.<br>Outcome: The students should able to calculate hardenability of steel<br>**Theoretical Background:** Concept of hardenability.<br>**Experimentation:** Jominy end quench test set up, medium carbon steel sample, cooling media is required**.**<br>**Results and discussion:** Hardness depends upon rate of cooling, effect of grain size,carbon content,alloying element. | 2 Hrs |
| **Experiment No. 10**) **Observation of various industrial heat treatments processes during industrial visits**<br>**Aim**: To observe surface heat treatment processes like carburising, nitriding,Induction Hardening processes<br>**Outcome**: At the end of visit the student should have brief knowledge of heat treatments.<br>**Theoretical Background:** Concept of surface hardening processes. | 4 Hrs |
| **Experiment No.11: One seminar on any advanced materials as well as selection of materials by referring at least 5 research papers from standard journals.**<br>**Aim:** To be aware of advanced materials and material selection process.<br>**Outcome**: At the end of presentation, the should have knowledge recent advanced materials and their selection process. | 2Hrs. |
| **Textbooks:**<br>1. 1 S.H. Avner, "Introduction to physical metallurgy", Mcgraw Hill Book Company Inc, Edition, 2nd, 1974.<br>2 Vijendrasingh, "Physical metallurgy", Standard Publishers Delhi | |

3. W. D Callister, “Material science and engineering”, Wiley India Pvt. Ltd., 5th Edition.
4. V.D. Kodgire, “Material science and metallurgy for engineers”, Everest Publishers Pune,12th Edition
5. T.V. Rajan / C.P. Sharma, “Heat Treatments Principles and Practices”, Prentice Hall of India Pvt Ltd, New Delhi
. 6. V Raghwan, “Material Science and Engineering”, Prentice Hall of India Pvt. Ltd., New Delhi ,3rd Edition, 1995..

**References:**

1] 1.V. Raghvan, “Materials Science & Engineering”, PHI 5th Edition, Prentice-Hall of India (P) Ltd.
2. W. Callister, “Materials Science & Engineering”, John Wiley & sons
3. References: 1 R.A. Higgins, “Engineering Metallurgy”, Viva Books Pvt. Ltd., New Delhi, 1 st Edition
5. ASM Handbook Volume no.5 Surface Engineering

**Experiment wise Measurable students Learning Outcomes:**

1.At the end of the expt. No.1 the student should be able to explain the working and construction of metallurgical microscope
2.At the end of the experiment 2, student should be able to determine properties like Tensile Strength, ductility, yield point, breaking stress.
3. At the end of the experiment the student should be able to find out hardness number of given material
4. The student should be able to determine Toughness value under impact loading conditions
5. The student should be able to apply different NDT technique.
6. Students should able to prepare Metallography samples for Micro structural analysis and Identify phases
7. At the end of the experiment the student should be able to find out phases in the non ferrous sample and their relation with the properties
8. At the end of the experiment the students should able to understand effect of heat treatment on mechanical properties of metals.
9: The students should able to calculate hardenability of steel
10. At the end of visit the student should have brief knowledge of heat treatments
11. At the end of presentation, the students should have knowledge of recent advanced materials and their selection process