# UNIVERSITY DEPARTMENTS,
# RAJASTHAN TECHNICAL UNIVERSITY, KOTA

## MTL206: Mathematics for Production & Industrial Engineering

**Credit: 4** **Max. Marks: 150 (IA:50, ETE:100)**

**3L+1T+0P** **End Term Exam: 3 Hours**

| S.No. | CONTENTS | HOURS |
|---|---|---|
| 1. | **Numerical Analysis:**<br>Interpolation, difference operators- forward, backward, central, shift and average operators, Newton's forward and backward interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's formula, Lagrange interpolation formula for unequal intervals. Inverse interpolation.<br>Numerical differentiation by Newton's, Gauss's and Stirling's formula. Numerical integration: Trapezoidal Rule, Simpson's 1/3 and 3/8 Rule.<br>Numerical solution of ODE of first order: Picard's method, Euler's method, Modified Euler's method, Runge-Kutta forth order method, Milne's Method.<br>Numerical solutions of simultaneous and higher order ODE: Runge-Kutta forth order method | **20** |
| 2. | **Statistics & Probability Theory**:<br>Curve Fitting: Fitting of a straight line, second degree parabola, power curve and exponential curves.<br>Correlation and Regression: Karl Pearson's coefficient of correlation, rank correlation, repeated ranks. Line of regression, regression coefficients, properties of regression coefficients.<br>Basic concepts of probability, conditional probability, Baye's theorem. Random variable and distributions: Discrete and continuous random variables, Moments, Expectation, Moment generating function, Binomial, Poisson, Discrete Uniform, Normal and Exponential distributions | **20** |
| | **Total Hours** | **40** |

**TEXT BOOKS:**

1. Advanced Engineering Mathematics, Jain and Iyengar, Narosa Publications.

**REFERENCE:**

1. Advanced Engineering Mathematics, Irvin Kreyszig, Wiley, India.
2. Advanced Engineering Mathematics, M. Greenberg, Pearson Education, India.
3. Engineering Mathematics for semesters III and IV, C.B. Gupta, Mc Graw Hill Education, India.
4. Advanced Engineering Mathematics, Denis Zill and Warren Wright, Jones & Bartlett India Private Limited.
5. Advanced Engineering Mathematics, O'neil, Cengage Learning, India.
6. Higher Engineering Mathematics, B. V. Ramana, Mc Graw Hill Education, India.
7. Numerical Methods for Scientific & Engineering Computation, Jain and Iyengar, Jain, New Age International Publication, India.
8. Introductory Methods of Numerical Analysis, S. S. Sastry, PHI Lerning, India.
9. Numerical Methods for Engineers, Chapra, Mc Graw Hill Education, India.
10. Introduction to Probability and Statistics, Seymour Lipschutz and John J. Schiller, Mc Graw Hill Education, India.

11. Fundamentals of mathematical statistics, S.C. Gupta and V.K. Kapoor, Sultan Chand & Sons., India.
12. Probability and Statistics, Murray Spiegel, John Schiller, R. Alu Srinivasan, McGraw Hill Education, India.

| **Course Outcome**:<br>The student will be able to: | |
|---|---|
| **CO1** | Demonstrate understanding of the basic concepts of numerical methods and mathematical statistics. |
| **CO2** | Apply and derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation and integration. |
| **CO3** | Demonstrate understanding and implementation of numerical solution applied to the classes of problems including ordinary differential equations. |
| **CO4** | Use various mathematical and statistical techniques required to solve engineering practical problems. |

**CO-PO Mapping (3-Strong, 2- Moderate and 1- Weak):**

| **Title of Course: Mathematics for Production & Industrial Engineering (MTL206)** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 2 | 2 | | | | | | | | | | |
| CO2 | 3 | 2 | | | | | | | | | | |
| CO3 | 2 | 3 | | | | | | | | | | |
| CO4 | 3 | 2 | 1 | | 1 | | | | | | | 1 |

**PIL130: ENGINEERING THERMODYNAMICS**

**B.Tech. (P&IE) 3rd semester**

**3L+0T**

| Unit | Contents | Contact hours |
|---|---|---|
| I | **Basic Concepts and definitions of Thermodynamics**: System, Surroundings, Property, Energy, Thermodynamic Equilibrium, Process, work and modes of work. | 2 |
| | **Zeroth and First Law of Thermodynamics:** Zeroth of Thermodynamics, Temperature scale, First law of thermodynamics, First law analysis of some elementary processes. Steady and unsteady flow energy equations. | 5 |
| II | **Second Law of Thermodynamics:** Heat engine, Heat pump and refrigerator, Second law of thermodynamics, Equivalence of the Kelvin-Plank and Clausius statements. Reversible and Irreversible Processes, Carnot engine, Efficiency of a Carnot engine, Carnot principle, thermodynamic temperature scale, Clausis Inequality. | 4 |
| | **Entropy**: Entropy, Calculation of Entropy change, Principle of entropy increase. Temperature-Entropy diagram, Second law analysis of a control volume. | 3 |
| | **Availability:** Available energy, Loss in available energy, Availability Function, Irreversibility. | 3 |
| III | **Thermodynamic Properties of Fluids:** Pure substance, Concept of Phase, Graphical representation of p-v-T data, Properties of steam. Steam tables, Mollier chart | 4 |
| | **Ideal Gas and Real Gas**: Ideal gas, Real gas, Internal energy, enthalpy and specific heats of an ideal gas, equations of state, Dalton's law of partial pressures, Gibbs Dalton law, Thermodynamic properties of gas mixtures. | 4 |
| IV | **Thermodynamic Relations:** Thermodynamic variables, Independent and dependent variables, Maxwell's thermodynamic relations, Thermodynamic relations involving entropy, Thermodynamic relations involving enthalpy and internal energy, Joule-Thomson coefficient, Clapeyron equation. | 4 |
| | **Power Cycles:** Otto cycle, Diesel cycle, Dual cycle, Brayton cycle and Ericsson cycle. | 5 |
| V | Vapour power cycle: Rankine cycle, effect of operating conditions on its efficiency, properties of ideal working fluid in vapour power cycle | 3 |
| | Reheat cycle, regenerative cycle, bleeding extraction cycle, feed water heating co-generation cycle. | 3 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | Nag P.K., Engineering Thermodynamics, Tata Mc-Graw Hill | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub.** |
| 1 | Chattopadhyay P., Engg Thermodynamics, Oxford University Press. | 2011 |
| 2 | Van G.J. Wylen and Sonntag R.E., Fundamental of Thermodynamics, J Wiley | 2003 |
| 3 | Cengel Y.A. and. Boles M.A, Thermodynamics-An Engg. Approach, TMH | 2011 |
| 4 | Jones J.B.&.Dugan R.E, Engineering Thermodynamics, PHI | 1996 |
| 5 | Rao Y.V.C., An Introduction to Thermodynamics, Wiley Eastern Ltd. | 1993 |
| 6 | Moran M.J and H.N. Shapiro, Fundamentals of Engineering Thermodynamics, John Wiley and Sons | 1996 |
| 7 | Rogers, Gorden., Engineering Thermodynamics, Pearson Education | 1996 |
| 8 | Kroos & Potter, Thermodynamics for Engineers, Cengage learning | 2015 |
| 9 | Mishra, Engineering Thermodynamics, Cengage learning. | 2015 |

**Course outcome**

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

**CO1:** Apply concepts of TD and Zeroth Law in solving numerical problems with relevant units.

**CO2:** Analyze and evaluate different forms work, heat and other properties by applying 1st Law of TD

**CO3:** Evaluate COP, EER, Efficiency, temperature and entropy by applying second law of TD and its corollaries.

**CO4:** : Illustrate problem solving procedure related to pure substances, ideal and real gases using PT, PV, TH diagrams

**CO5:** Correlate various thermodynamic variables in thermodynamic relations.

**CO6:** Evaluate vapour and gas power cycles, its components and summarize performance on the basis of different parameters

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | | | | | | | | | 1 |
| **CO2** | 3 | 3 | 2 | 2 | | | | | | | | 2 |
| **CO3** | 3 | 3 | 2 | 2 | | | 2 | | | | | 2 |
| **CO4** | 3 | 3 | 1 | | | | | | | | | |
| **CO5** | 3 | 3 | 1 | | | | | | | | | |
| **CO6** | 3 | 3 | 2 | 3 | | | 2 | | | | | 2 |
| **Average** | **3.0** | **3.0** | **1.5** | **2.3** | | | **2.0** | | | | | **1.8** |

# PIL120:Applied Mechanics

**B.Tech. (P&IE) 3rd semester**
**3L+0T**

| Unit | Details | Hours |
|---|---|---|
| I | Statics of Rigid Bodies: Forces and Moments, Equilibrium of rigid bodies, Free body diagrams. | 4 |
| | Virtual work: Introduction, Work of force and couple, Principle of Virtual work and its applications | 3 |
| II | Stress and Strain: Elementary definition of stress and strain, stress-strain relationship, elastic, plastic and visco-elastic behavior of common materials in tension and compression test, stress-strain curves, Hooke's law, Poisson's ratio, elastic constants and their relations for an isotropic Hookean material. | 4 |
| | Tension, compression, shearing stress and strain, thermal stresses, composite bars, equations of static equilibrium, concept of free body diagram. Strain energy due to axial loading. | 5 |
| III | Members Subjected to Flexural Loads: Theory of simple bending, bending moment and shear force diagrams for different types of static loading and support conditions on beams. | 5 |
| | Bending stresses, section modulus and transverse shear stress distribution in circular, hollow circular, I, Box, T, angle sections etc. Strain energy due to bending | 4 |
| IV | Principal Planes, Stresses and Strains: Members subjected to combined axial, bending and torsional loads, maximum normal and shear stresses, concept of equivalent bending and equivalent twisting moments, Mohr's circle of stress and strain. | 6 |
| V | Torsion: Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity. Strain energy due to torsional loads. | 4 |
| | Transverse Deflection of Beams: Relation between deflection, bending moment, shear force and load, transverse deflection of beams and shaft under static loading, area moment method, direct integration method. | 5 |

## TEXT BOOKS& OTHER REFERENCES BOOKS

| Text Books | |
|---|---|
| 1. | Surendra Singh, "Strength of Materials", M/s S K Kataria& Sons, 2013 |
| 2. | Rattan S.S., "Strength of Materails", Mc Graw Hill Education (India) Pvt Ltd., Third Edition, 2017 |
| 3. | Sharma D. P., "Mechanics: Problems and Solutions", Pearson Education, |
| **Suggested / Reference Books** | |
| 1. | Timoshenko, S.P., and Gere, J.M., "Mechanics of Materials", 2nd Ed., CBS Publishers |
| 2. | Crandall, S.H., Dahl, N.C., and Lardner, T.J., "An Introduction to the Mechanics of Solids", Tata McGraw-Hill |
| 3. | Pytel and Kiusalaas, "Mechanics of Materials" Cengage Learning |
| 4. | Beer, Johnston, et al, "Vector Mechanics for Engineers", McGraw Hill, 2019. |

| Websites References | |
|---|---|
| **1.** | https://nptel.ac.in/courses/112/102/112102284/ (NPTEL course on Solid Mechanics, IITD) |
| **2.** | https://ocw.mit.edu/courses/mechanical-engineering/2-001-mechanics-materials-i-fall-2006/download-course-materials/ (MIT open course ware on Mechanics & Materials) |
| **3.** | https://nptel.ac.in/courses/112/106/112106141/ (NPTEL course on Strength of Materials IIT Madras) |

## Course Outcomes:

Upon successful completion of this course, students will be able to:

**CO1:** Determine the forces and moments from equilibrium relationship and apply the principle of virtual work to solve practical problems.

**CO2:**Understand the fundamental concept of stress and strain, and the relationship between both in order to solve problems on principle of superposition, compound bars, and thermal stresses.

**CO3:**Apply the theory of simple bending to seek solution related to the pure and non-uniform bending of beams.

**CO4:**Analyze the members/structure subjected to combined loading and identify the principle planes/stress/strain.

**CO5:**Evaluate the torsional stress for various cases of shaft and apply different methods to evaluate deflection of beam.

# PIL110: PRINCIPLES & PRACTICES OF MANAGEMENT

**B.Tech. (P&I) 3rd Semester**

**3L+0T**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | Management: Definition including conceptual analysis, functions. Evolution of management thought, scientific management, contributions of Taylor, Gilbert, Gantt, Elton Mayo, Henry Fayol and others. | 5 |
| | Management process & systems approach to Management, functions of managers. Levels of management, Administration & Mnmgt. Decision making. | 3 |
| II | Forms of ownership: Proprietorship, partnership, joint stock company, private and public limited companies, Joint Stock Companies: Co operative Society, choice of business forms and state undertakings. Multinational corporations. | 4 |
| | Management Planning: Managerial planning, Type of plans, steps in planning; mission, objectives, strategies, policies, procedures, rules and programs. Managing by objectives, strategic planning process, SWOT analysis. | 4 |
| III | Organizing: Meaning of organizing and organization, formal and informal organization, span of management, process of organizing. Organizational structure: Line organization, functional organization, matrix organization, strategic business units. Line/Staff concepts, empowerment, and decentralization, delegation of authority. | 5 |
| | Effective organizing and organizational culture. Staffing: overview, factors affecting staffing, systems approach, job design, selection, Performance appraisal, rewards. Career strategy, managerial training. Managing change. | 4 |
| IV | Human factors in managing Motivation : Theory X, Theory Y, Maslow's hierarchy of needs, Hertzberg's hygiene theory, porter and Lawler model, equity theory, Reinforcement theory, McClelland's theory behavioural model. | 5 |
| | Motivational techniques, job enrichment. Leadership: traits, approaches situational, contingency, path goal approach, transactional and transformational leadership. | 3 |
| V | Group decision making: Reasons for using Committees and groups, successful operation of committees and groups, working in teams. Communication: purpose, process of communication, communication flow in the organization, barriers to communication, Improvement of communication; role of electronic media in communication. | 5 |
| | Controlling: Basic control process, feed forward and feedback control, performance measures and control, requirement of effective control, use of Information Technology for control. | 3 |


| **TEXT BOOK** | | |
|---|---|---|
| **1** | Essentials of Managements an Introduction, Koontz, Tata McGraw-Hill, New Delhi. | 2002 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub.** |
| **1** | Fundamentals of Managements, Robbins, Pearson Education | 1995 |
| **2** | Works Organisation and Management, Basu and Sahu, IBH | 2005 |
| **3** | Industrial Organisation and Management, Bethel, Atwater, Smith &Stachmax, McGraw Hill | 2010 |
| **4** | Principles of Industrial Organization, Kimbal and Kimbal, McGraw Hill | 2008 |
| **5** | Principles of Industrial Management, Leon Pratt Alford, Henry Russell Beatty, Revised Edition, Ronald Press Co. | 2001 |
| **6** | Works Organisation & Mgt, SK Basu, K. C. Sahu, N. K. Datta , Oxford & IBH. | 1992 |
| **7** | Management, Griffin, John Wiley and Sons. | 2002 |
| **8** | Management: Tasks, Responsibilities &Practices, Drucker P. F., Allied Pub. | 1995 |
| **8** | Raju, Industrial Engg and Management, Cengage learning | 2015 |

## PIL110 Principles and Practices of Management

### Course outcome

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

**CO1:** Describe the basic concepts and theories related to scientific management.

**CO2:** Identify the need and scope of ownership and planning.

**CO3:** Discuss the need and scope of organising and staffing.

**CO4:** Apply various theories and techniques related to human factors for motivation.

**CO5:** Evaluate the communication needs ,barriers and constraint in an organisation and identify management control process and its implications.

### CO-PO Mapping

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | | | 2 | | | 1 | | | | | |
| **CO2** | 1 | | 2 | | | | | | | | | | | |
| **CO3** | | | 2 | | | | | | 1 | 1 | | | | |
| **CO4** | 2 | | | | | 1 | | 1 | | 1 | | | | |
| **CO5** | 2 | 2 | 2 | 2 | 2 | | | | | | | | | |

# PIL111: FOUNDRY, WELDING & MATERIAL TECHNOLOGY

**B.Tech. (P&I) 3rd semester**

**4L+0T**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | General Classification and Introduction to Manufacturing processes.<br>**Pattern Practice:** Introduction, advantage and disadvantages of casting over other manufacturing process, requirement of a good pattern, types of patterns, pattern materials, pattern allowances. | 3 |
| | **Moulding Practice:** Moulding sands: types, composition, properties, and testing - Grain fineness; moisture content, clay content and permeability test.; types of moulds, moulding processes, moulding machines; Cores: Functions of core, type of cores, core print, core box, Gating system: types, pouring basin, sprue, gating ratio, chills, runner and risers; Gating system design and risering design, pouring time. | 4 |
| II | **Casting Practice:** Basic rules for good casting design, Foundry equipment and furnaces. Melting, pouring and solidification. | 2 |
| | Sand casting, plaster-mould casting, vacuum casting, Investment casting, slush casting, centrifugal casting, continuous casting. Cleaning and finishing of casting | 3 |
| III | **Welding processes**: Introduction, advantages, disadvantages and application of welding, Classification of welding process, Pressure welding: forge welding, resistance electric welding, butt welding, flash welding, spot welding, seam welding, projection welding. gas welding, electric arc welding, Thermit welding. | 3 |
| | weldability,Welding electrodes, selection of welding electrodes, flux. soldering and brazing. | 3 |
| IV | TIG welding, MIG welding, submerged arc welding, plasma arc welding, laser beam welding, under water welding. | 3 |
| | heat treatment of weldments, | |
| V | **Testing of Castings and Weldments:** Causes and remedies for casting defects, welding defects. Destructive testing methods: tensile test, compression test, bend test, impact test, hardness test. | 3 |
| | Non destructive testing methods: visual inspection, leak test, X-ray radiography, magnetic particle test, liquid penetration test, fluorescent penetration test, ultrasonic test, eddy-current test, | 2 |
| | **SUB-TOTAL** | **26** |

| Unit | Contents | Contact Hours |
|---|---|---|
| | **Material Technology** | |
| I | Crystal structure – BCC, FCC and HCP, unit cell, crystallographic planes and directions, miller indices. Crystal imperfections, point, line, surface and volume defects. Frank Reed source of dislocation, Elastic & plastic modes of deformation, Bauschinger's effect, slip & twinning, strain hardening, Cold/hot working: recovery, re-crystallization and grain growth. | 6 |
| II | Classification of Engineering Materials: Solidification of metals and of some typical alloys, mechanism of crystallization (I) nuclear formation (ii) crystal growth, general principles of phase transformation in alloys, phase rule and equilibrium diagrams, equilibrium diagram of binary system having complete mutual solubility in liquid state and limited solubility in solid state, binary isomorphous alloy system, Hume-Rothery rule , binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature | |

| | | |
|---|---|---|
| | and also alloy with a peritectic transformation, equilibrium diagram of a system whose components are subject to allotropic change. | |
| | Iron carbon equilibrium diagram, phase transformation in the iron carbon diagram, eutectic, peritectic, eutectoid and peritectoid reactions and microstructures. | **3** |
| **III** | Isothermal transformation diagrams – cooling curves superimposed on Isothermal Transformation diagram, critical cooling rate. (i) Formation of Austenite from Pearlite (ii) Transformation of Austenite into Pearlite.<br>Full annealing, stress relief, spheroidizing – normalizing, hardening and tempering of steel. Hardenability, Jominey end quench test – Austempering, martempering. Case hardening, carburising, nitriding, cyaniding, carbo nitriding. Flame and Induction hardening.<br><br>Classification of steels & cast iron, constitution and properties. BIS standards.<br>Effect of alloying additions on steel (Mn, Si, Cr, Mo, V, Ti & W) - stainless and tool steels – HSLA steel. | **9** |
| | **SUB-TOTAL** | **24** |
| | **TOTAL** | **50** |
| | | |

| | | |
|---|---|---|
| **TEXT BOOK** | | |
| **1** | Material Science and Engineering An Introduction, William D.Callister, John Wiley and Sons. | **2003** |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub.** |
| **1** | Material Science, Raghvan V., Prentice Hall India | **2012** |
| **2** | Principles of Material Science and Engineering, William F.Smith, Tata McGraw-Hill Publications. | **2008** |
| **3** | Engineering Physical Metallurgy, Lakhtin Y., Mir Publisher. | |
| **4** | Introduction to Engineering materials Tata McGraw-Hill Publications. | **2011** |
| **6** | Material Science and Engineering properties, Gilmore, Cengage Learning | **2015** |

| | | |
|---|---|---|
| **TEXT BOOK** | | |
| **1** | Rao.P.N., Manufacturing Technology, Vol. 1, Tata McGraw Hill | **2013** |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub.** |
| **1** | Ghosh, A., & Mallik, A. K. 1986. Manufacturing Science: Ellis Horwood. | **1999** |
| **2** | Schey, Introduction to Manufacturing Processes, Tata McGraw Hill | **2000** |
| **3** | Kalpakjian, S., & Schmid, S. R., Manufacturing processes for engineering materials, Pearson Education. | **2008** |
| **4** | Campbell, J. S. Principles of manufacturing materials and processes: TMH | **1999** |
| **5** | Heine,, Loper, C.R., and Rosenthal, P.C., "Principles of Metal casting", TMH | **1976** |
| **6** | Groover, M.P., Fundamentals of Modern Manufacturing: Materials, Processes and systems, Prentice Hall, New Jersey | **2007** |
| **7** | Kalpakjian, S. & Schmid S.R, Manufacturing Engineering and Technology, Addison Wesley Longman | **2000** |
| **8** | Little, R.L., Welding and welding technology Tata McGraw-Hill Education | **1973** |
| **9** | Shan, H.S., Manufacturing Process, Pearson Education. | **2012** |
| **10** | Principle of Foundry Technology , P.L.Jain, Tata McGraw Hill, 2003 | |
| **11** | Modern Welding Technology, B.Curry, Prentice Hall, | 2002 |
| **12** | Welding Principle & applications ,Larry Jeff in Delmar, | 1997 |
| **13** | Foundry Engineering ,Taylor HF Fleming, M.C. & Wiley Eastern Ltd. | |

**PIP112: PRODUCTION PRACTICE-I**

B.Tech. (P&I) 3rd Semester

**0L+0T+3P**

| SN | NAME OF EXPERIMENT |
|---|---|
| 1 | To study lathe machine construction and various parts including attachments, lathe tools cutting speed, feed and depth of cut. |
| 2 | To perform step turning, knurling and chamfering on lathe machine as per drawing. |
| 3 | To perform taper turning by<br>(a) tailstock offset method as per drawing<br>(b) compound rest.<br>(c) Taper turning attachment<br>(d) Form tool |
| 4 | To prepare the job by eccentric turning on lathe machine. |
| 5 | To study shaper machine, its mechanism and calculate quick return ratio. |
| 6 | To prepare a job on shaper from given mild steel rod. |

# COURSE OUTCOME

| Course Code | Course Name | Course Outcome | Details |
|---|---|---|---|
| 3PIU7 | PRODUCTION PRACTICE - I | CO1 | To learn parametric aspects of machining, working principle and machining process. |
| | | CO2 | Learn and practice the machining operation and tools used in machining. |
| | | CO3 | Learn to operate the machine used in mechanical engineering workshop. |

# CO-PO MAPPING

| | Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PRODUCTION PRACTICE - I | CO1 | 3 | 2 | 2 | | | | | | | | | |
| | CO2 | 3 | 3 | | | | | | | | | | |
| | CO3 | 3 | 3 | 3 | | | | | | | | | |
| | Average | 3 | 2.66 | 2.5 | | | | | | | | | |

**PIP120: PRODUCTION ENGINEERING DRAWING AND CAD LAB**

**0L+0T+2P**

| SN | CONTENTS |
|---|---|
| | Assembly drawing with sectioning and bill of materials of the following: Lathe tail stock, shaper tool head, machine vice etc (1 drawing sheet of any assembly)<br>Detailed part drawings from assembly drawing indicating fits, tolerances and surface finish symbols by referring BIS codes: Check-valve, Junction Valve, Journal bearing etc (1 drawing sheet for parts drawing of any assembly)<br>Free hand sketches of simple mechanical systems.<br>Computer Aided Drafting: Introduction to different features of the CAD Software (AutoCAD/ProE/ Creo/Solidworks etc). At least one drawing problem related to<br>a. 2-D Drafting.<br>b. 3-D Modeling.<br>c. 3-D Advanced Modeling.<br>d. Assembly modeling.<br>e. Feature Modification and Manipulation<br>f. Detailing.<br>g. Surface Modeling |

| **TEXT BOOK** | |
|---|---|
| **1** | Laxminarayan and M.L. Mathur,Machine Drawing ,Jain Brothers |
| **REFERENCE BOOKS** | |
| **SN** | **Name of Authors /Books /Publisher** |
| **1** | Gill P S, Machine Drawing, Kataria & Sons |
| **2** | Basudeb Bhattacharya, Machine Drawing, Oxford University Press |
| **3** | Junnarkar N D, Machine Drawing, Pearson Education, |
| **4** | Goutam Pohit and Goutam Ghosh, Machine Drawing with AutoCAD, Pearson Education |
| **5** | Ostrowsky, O., Engineering Drawing with CAD Applications, ELBS |
| **6** | Siddeshswar N., P Kannaiah, VVS Shastry, Machine Drawing,TMH |

## Course outcome

| **At the end of the course, the student will be able to** |
|---|
| **CO1:** Construct assembly drawing of mechanical systems with bill of materials. |
| **CO2:** Interpret assembly drawings and prepare part drawings indicating fits, tolerances, surface finish. |
| **CO3:** Produce freehand sketches of mechanical systems and its parts. |
| **CO4:** Develop 2-D and 3-D models on CAD software. |

**PIP111: MATERIAL SCIENCE LAB.**

**B.Tech. (P&IE) 3rd Semester** **Max. Marks: 50**

**0L+0T+2P**

| SN | NAME OF EXPERIMENT |
|---|---|
| 1 | (a) Study of various crystals structures through models BCC, FCC, HCP, tetrahedral and octahedral voids.<br>(b) Material identification of, say, 50 common items kept in a box. |
| 2 | Specimen preparation for metallographic examination /micro structural examination-cutting, grinding, polishing, etching. |
| 3 | Comparative study of microstructures of different given specimens (mild steel, gray C.I., brass, copper etc.) |
| 4 | Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after. |
| 5 | Study of Microstructure and hardness of steel at different rates of cooling. Microstructure examination of white cast iron. |
| 6 | To perform Tensile/Compressive/Shear/torsion test on a given material and to determine its various mechanical properties under tensile/compression/Shear/torsional loading |
| 7 | To determine Rockwell/ Vickers/Brinell hardness of a given material |
| 8 | To perform Impact test on a given material and to determine its resilience. |
| 9 | To study and perform Fatigue test on a given material and to determine fatigue strength of the material |
| 10 | To perform Bending test and to determine the Young's Modulus of Elasticity via deflection of beam. |
| 11 | Creep testing on creep testing machine. |

| REFERENCE BOOKS | | |
|---|---|---|
| SN | Name of Authors /Books /Publisher | Year of Pub. |
| 1 | Vander Voort, Metallography: Principles and Practice, McGraw-Hill, | 1984 |
| 2 | Prabhudev K.H., Handbook of Heat Treatment of Steels, TMH | 2000 |
| 3 | Suryanarayanan, A.V.K. "Testing of Metalic materials" TMH | 1993 |
| 4 | Abbaschian, Physical metallurgy principles, Cengage Learning | |

CO1: Understand the basic concepts of material science, to learn about different types of crystal system.
CO2: Analyse different mechanism of plastic deformation.
CO3: Analyse the effect of heat treatment on properties of steel.
CO4: In depth knowledge and comparison of properties of different materials.

| COURSE OUTCOME | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | - |
| C02 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - |
| C03 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - |
| C04 | 3 | 3 | 2 | 2 | - | - | - | - | - | - | - | - |

**PIL110: FOUNDRY & WELDING LAB.**

**B.Tech. (P&I) 3rd Semester**

| | |
|---|---|
| **1** | To prepare mould of a given pattern requiring core and to cast it in aluminium. |
| **2** | To perform moisture content test. |
| | To perform clay content test. |
| **3** | Strength Test (compressive, Tensile, Shear Transverse etc. in green and dry conditions) and Hardness Test (Mould and Core). |
| **4** | To perform permeability test |
| **5** | To perform Grain fineness (A.F.S. Sieve analysis) test. |
| | |
| **6** | Hands-on practice on spot welding. |
| **7** | Hands-on practice on submerged arc welding |
| **8** | Hands-on practice on metal inert gas welding (MIG). |
| **9** | Hands-on practice on tungsten inert gas welding (TIG). |
| **10.** | Non destructive testing of welding joints by<br>• Visual Examination<br>• X-ray/Radiographic Inspection<br>• Magnetic Particle Inspection<br>• Liquid Penetrant Testing<br>• Ultrasonic Testing (flat welds) |

| | |
|---|---|
| CO1 | Explain principles, materials and methods of foundry technology. |
| CO2 | Understand and perform sand mould testing methods. |
| CO3 | Learn and perform the spot, submerged arc, MIG, TIG welding operations. |
| CO4 | Select an appropriate NDT technique as per requirement |
| CO5 | Identify the internal flaws in the material by NDT and take measures to eliminate them |
| CO6 | Solve various problems encountered like leakage, cracks, blowholes etc with the manufacturing process by analyzing the data |

## CO-PO MAPPING

| | Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FOUNDRY AND WELDING LAB | **CO1** | 3 | | | | | | | | | | | |
| | **CO2** | 3 | 2 | | | | | | | | | | |
| | **CO3** | 3 | 2 | | | 2 | | | | | | | |
| | **CO4** | 3 | 3 | | | 2 | | | | | | | |
| | **CO5** | 3 | 3 | | | 2 | | | | | | | 2 |
| | **CO6** | 2 | 3 | | 3 | | | | | | | | 3 |
| | **Average** | 2.8 | 2.6 | | 3 | 2 | | | | | | | 2.5 |

# PIL210: MACHINING SCIENCES

**B.Tech. (P&I) 4th semester**
**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | Classification of metal removal process and Classification of machine tools, Geometry of single point cutting tool and tool angles, tool nomenclature in ASA and ORS. Concept of orthogonal and oblique cutting. | 5 |
| II | Chip Formation, Mechanics of metal cutting, shear angle and its relevance, various theories of metal cutting. Thermal aspects of machining and measurement of chip tool interface temperature. machinability, tool wear, tool life, Cutting fluids, Economics of machining, Measurement of cutting forces. | 2 |
| III | Lathe: Construction and cutting speed, feed, and depth of cut, machining time and power estimation. Capstan and turret lathe machines, tool layout.<br>Shaper: Construction and working principle, Quick return mechanism. | 4 |
| | Milling: Introduction, types of milling machines, milling cutters, milling operations, dividing head, Indexing methods, machining time and power estimation and gear cutting. | 4 |
| IV | Gear hobbing, gear shaping. Gear finishing processes: shaving, grinding, lapping and shot blasting | 3 |
| | Drilling: - tool geometry of twist drills, types of drills, drilling machine construction, drilling time and force estimation | 5 |
| V | Grinding- Need and different methods of grinding, grinding wheel designation and selection, Dressing and truing, Types of grinding machines, Grinding process. Honing, lapping, super finishing, polishing and buffing processes. | 4 |


| TEXT BOOK | | |
|---|---|---|
| 1 | Lal G.K., Introduction to Machining Science, New Age international Publishers. | 2007 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub.** |
| 1 | Rao.P.N., Manufacturing Technology, Vol. 1,2 and 3, Tata McGraw Hill | 2013 |
| 2 | Ghosh, A., & Mallik, A. K.. Manufacturing Science: East West Press Private Limited. | 1986 |
| 3 | Schey, Introduction to Manufacturing Processes, Tata McGraw Hill | 2000 |
| 4 | Kalpakjian, S., & Schmid, S. R., Manufacturing processes for engineering materials, Pearson Education. | 2008 |
| 5 | Pandey & Singh, Production Engineering Science, Standard Publishers Distributer, Delhi. | 1999 |
| 6 | Stephenson, D. A., & Agapiou, J. S. Metal cutting theory and practice: CRC Taylor & Francis. | 2006 |
| 7 | Karl H.Heller, All About Machine Tools, Wiley Eastern Ltd., New Delhi | 1972 |
| 8 | Kalpakjian, S. & Schmid S.R, Manufacturing Engineering and Technology, Addison Wesley Pub. Co. | 2000 |
| 9 | Sen, G. C., & Bhattacharyya, A. Principles of Machine Tools: New Central Book Agency | 1988 |
| 10 | Bhattacharyya A, Theory & Practice of Metal Cutting, New Central Book Agency | 2006 |
| 11 | Shan, H.S., Manufacturing Process, Pearson Education. | 2012 |

| | | |
|---|---|---|
| **12** | Boothroyd, G., & Knight, W. A. Fundamentals of machining and machine tools: Taylor and Francis. | **2006** |
| **13** | Milton C. Shaw, Metal Cutting Principles, CBS Publishers. | **2005** |
| **14** | Trent, E. M. Metal cutting: Butterworth Heinemann | **2000** |


CO1: Acquires the fundamental knowledge and principles in material removal processes.
CO2: Demonstrate the fundamentals of machining, finishing, SPM processes and machine tools.
CO3: Evaluate the importance of input and output metal cutting parameters.
CO4: Learn about tool materials, cutting fluid and tool wear mode / mechanism.
CO5: Understand and analyse about high velocity forming methods.

| Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 3 | 3 | 2 | 3 | - | - | - | - | - | - | - | - |
| C02 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - | - |
| C03 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | - | - |
| C04 | 3 | 3 | 3 | 3 | - | - | - | - | - | - | - | - |
| CO5 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | - | - |

# PIL220: DESIGN OF MACHINE ELEMENTS

**B.Tech. (P&I) 4th semester**

**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Design Criteria:** Strength, Stiffness, aesthetics, ergonomics<br>Design for Manufacturing: Design consideration for cast, forged and machined parts.<br>**Theories of Elastic Failures:** The necessity for a theory, different theories, significance and comparison, applications<br>**Design for Assembly:** Introduction, Limits, fits and tolerances, Interchangeability, standardization.<br>**Materials:** Selection of material from properties and economic aspects. Mechanical Properties and IS coding of various materials, | 7 |
| II | **Design for Strength**: Modes of failure, Allowable stresses, factor of safety.<br>**Stress concentration:** causes and mitigation. | 4 |
| | **Design of Members subjected to direct stress**: Cotter joints.<br>**Couplings*:*** Design of muff coupling, flanged couplings: rigid and flexible | 5 |
| III | **Design of Members in Bending**: Levers and laminated springs.<br>**Design for stiffness:** Introduction, Specific cases of beam design on the basis of maximum deflection. Deflection by double integration method | 7 |
| IV | **Design of Threaded fasteners**: Bolt of uniform strength, Preloading of bolts: Effect of initial tension and applied loads, Eccentric loading | 5 |
| | Power screws like lead screw, screw jack | 3 |
| V | **Fatigue Considerations in Design:** Variable load, loading pattern, endurance stresses, Influence of size, surface finish, notch sensitivity and stress concentration. | 3 |
| | Goodman line, Soderberg line, Design of machine members subjected to combined, steady and alternating stresses. | 4 |
| | Design for finite life, Design of Shafts under Variable Stresses | 2 |
| | **Total** | 40 |

| TEXT BOOK | | |
|---|---|---|
| 1 | Bhandari, V. B., Introduction to Machine Design, McGraw Hill Education (India) | 2013 |

| REFERENCE BOOKS | | |
|---|---|---|
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | Bahl and Goel, Mechanical Machine Design, Standard Publishers Distributors | 2002 |
| 2 | Shigley, Joseph E., Mechanical Engineering Design, McGraw Hill Education (India) | 2002 |
| 3 | Sharma and Aggarwal, Machine Design, S.K.Kataria and Sons, Delhi. | 1997 |
| 4 | Sharma and Purohit, Design of Machine Elements, Prentice Hall India. | 2002 |
| 5 | Jindal U C, Machine Design, Pearson Education India | 2010 |

## COURSE OUTCOME

| Course Code | Course Name | Course Outcome | Details |
|---|---|---|---|
| 4PIU1 | DESIGN OF MACHINE ELEMENT-I | CO1 | Describe various design criteria and explain material and failure theories. |
| | | CO2 | Determine the sizes of the parts of cotter and knuckle joints considering various modes of failure. |
| | | CO3 | Design the bending members like Lever and laminated spring based on strength and stiffness consideration. |
| | | CO4 | Design of coupling under torsional loading. |
| | | CO5 | Compute and select the bolt size for different loading conditions. |
| | | CO6 | Predict the failure of machine component under fatigue loading conditions and design the components for finite and infinite life. |

## CO-PO MAPPING

| | Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DESIGN OF MACHINE ELEMENT-I | CO1 | 3 | 2 | 2 | 1 | | | | | | | | |
| | CO2 | 2 | 3 | 3 | 1 | | | | | | | | |
| | CO3 | 2 | 3 | 3 | 1 | | | | | | | | |
| | CO4 | 2 | 3 | 3 | 1 | | | | | | | | |
| | CO5 | 2 | 3 | 2 | 1 | | | | | | | | |
| | Average | 2.2 | 2.8 | 2.6 | 1 | | | | | | | | |

# PIL230: THERMAL ENGINEERING

**B.Tech. (P&IE) 4th semester**
**3L+0T**

| Unit | Contents | Contact hours |
|---|---|---|
| I | **Heat Transfer**: Introduction, Fourier's law of conduction, Newton Rikhman equation, Stefan Boltzmann law, Overall heat transfer coefficient. | 2 |
| | Conduction: Three dimensional heat flow equation-Cartesian coordinates. One dimensional steady state conduction without heat generation, One dimensional flow through a plane wall, composite wall and tube, thick spherical shell, Critical insulation, Heat flow through fins. | 6 |
| II | **Convection**: Dimensional analysis of forced and free convection, empirical relations. | 5 |
| | **Radiation:** Introduction, Absorption, reflection and transmission, Monochromatic, total emissive power, view factor | 3 |
| III | **Heat exchanger**: Types of Heat Exchanger, LMTD equation for parallel and counter flow Heat Exchanger and its applications. Effectiveness - NTU Method | 8 |
| IV | **Refrigeration:** Air refrigeration system, vapour compression and vapour absorption system, steam refrigeration | 4 |
| | Refrigerants, Refrigeration equipments, Reciprocating Air Compressor. | 4 |
| V | **Air Conditioning**: Properties of moist air, Psychrometric chart and its use, Elementary psychrometric processes. Comfort Air Conditioning. | 8 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | J.P. Halman, Heat Transfer, Mc Graw Hill | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | Incropera and Dewitt, Fundamental of Heat and Mass transfer, J. Wiley | 2007 |
| 2 | Cengel, Heat and Mass transfer, Mc Graw Hill | 2011 |
| 3 | M.Thirumaleshwar, Fundamental of Heat and Mass Transfer, Pearson Ed. | 2006 |
| 4 | Ozisik, Heat and Mass Transfer, Mc Graw Hill | 2009 |
| 5 | C.P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill. | 2008 |

**Course outcome**

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

**CO1:** Describe various modes of heat transfer. Analyze heat conduction equation in Cartesian coordinates. And apply principles of heat flow through fins

**CO2:** Explain dimensional analysis of forced and free convection. Illustrate concepts of radiation.

**CO3:** Analyze the performance of heat exchangers

**CO4:** Describe various refrigeration systems, refrigerants and equipments.

**CO5:** Explain Properties of moist air, Psychrometric chart and its use, Elementary psychrometric processes and comfort Air Conditioning

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 PSO1 PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | | | | | | | | | 1 |
| **CO2** | 3 | 3 | 2 | 2 | | | | | | | | 2 |
| **CO3** | 3 | 3 | 2 | 3 | | | 2 | | | | | 2 |
| **CO4** | 3 | 3 | 2 | 2 | | | 2 | | | | | 1 |
| **CO5** | 3 | 3 | 2 | 2 | | | 2 | | | | | 1 |
| **Average** | **3.0** | **3.0** | **1.8** | **2.3** | | | **2.0** | | | | | **1.4** |

# PIL231: FLUID ENGINEERING

**B.Tech. (P&I) 4TH Semester**
**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Fluid Properties**: Definition of a fluid, Viscosity-dynamic and kinematic, Surface Tension. | 3 |
| | **Fluid Statics:** Basic equation of fluid statics, Manometers, Force on plane areas and curved surfaces, center of pressure, Buoyant force, Stability of floating and submerged bodies. | 5 |
| II | **Fluid flow concepts and Basic control volume equations**: General control equation, conservation of mass, energy equation and its application, Momentum equation and its applications | 4 |
| | **Basic governing differential equation**: Reynolds transport equation, continuity equation, momentum equation, energy equation, Bernoulli's equation. | 4 |
| III | **Viscous flow:** Laminar flow through pipe and between parallel plate. | 4 |
| | **Turbulent flow:** Relation, Prandle mixing length, Losses in open and closed conduit | 4 |
| IV | **Measurements**: Pressure, velocity, flow measurement-orifices, venturimenter, orificemeter, nozzle meter, notches and weirs. | 3 |
| | **Flow through pipe:** Major and minor Losses in pipe, Hydraulic and energy gradient line, Network of pipes-series and parallel. | 5 |
| V | **Hydraulic Turbines:** Classification of hydraulic turbines, work done and efficiencies of Pelton, Francis and Kaplan turbines, Draft tube, Specific speed and unit quantities | 5 |
| | **Hydraulic systems:** Hydraulic press, Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump. | 3 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Yunus A. Cengel and Cimbala, Fluid Mechanics, Tata McGrawHill, | **2006** |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub.** |
| **1** | Streeter V.L., K.W. Bedford and E.B.Wylie , Fluid Mechanics , TMH | **2010** |
| **2** | Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, John Wiley & Sons. | **2009** |
| **3** | Potter, Mechanics of Fluids, Cengage Learning. | **2012** |
| **4** | Frank M. White, Fluid Mechanics, Tata McGraw Hill. | **2003** |
| **5** | John F. Douglas, Fluid Mechanics, Pearson Education. | **2007** |
| **6** | Munson, B. R., Young, D. F., & Okiishi, T. H. Fundamentals of Fluid Mechanics, Wiley | |
| **7** | Som, S. K., & Biswas, G. Introduction to fluid mechanics and fluid machines, Tata McGraw Hill. | **2010** |
| **8** | K.Subramaanya, Hydraulic Machines, McGrawhill, | **2013** |
| **9** | Modi and Seth, Fluid Mechanics and Hydraulic Machinery, Standard Book House | **1991** |

**Course outcome**

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

**CO1:** Identify and calculate the key fluid properties used in the analysis of fluid behavior. Describe and apply the principles of pressure, pressure measurement, fluid statics, buoyancy and floatation.

**CO2:** Apply and deduce the concept of basic governing differential equation of conservation of mass, energy and momentum alongwith their application

**CO3:** Describe and analyze viscous and turbulent flow.

**CO4:** Understand and apply the principle of Bernoulliβ€™s equation for fluid flow measurement and to identify the major and minor energy losses that is involved in a fluid flow and their accountability.

**CO5:** Study and analysis of hydraulic turbines, Hydraulic press, Hydraulic accumulator, Hydraulic Intensifier, Hydraulic Ram, Hydraulic lift, Hydraulic coupling, Hydraulic torque convertor Gear pump.

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 2 | | | | | | | | | 1 |
| **CO2** | 3 | 3 | 3 | 2 | | | | | | | | | 1 |
| **CO3** | 3 | 3 | 3 | 2 | | | | | | | | | 1 |
| **CO4** | 3 | 3 | 2 | 2 | | | 2 | | | | | | 1 |
| **CO5** | 3 | 3 | 2 | 2 | | | 2 | | | | | | 1 |
| **Average** | **3.0** | | **3.0** | **2.6** | **2.0** | | **2.0** | **1.0** | | | | | |

# PIP210:PRODUCTION PRACTICE - II

**B.Tech. (P&I) 4th semester**
**0L+0T +3P**

| UNIT | NAME OF EXPERIMENT |
|---|---|
| **1** | To study of single point cutting tool geometry and to grind the tool as per given tool geometry. |
| **2** | To study the milling machine, milling cutters, indexing heads and indexing methods and to prepare a gear on milling machine. |
| **3** | To machine a hexagonal / octagonal nut using indexing head on milling machine. |
| **4** | To cut BSW/Metric internal threads on lathe machine. |
| **5** | To cut multi-start Square/Metric threads on lathe machine. |
| | Boring using a boring bar in a centre lathe. |
| **6** | Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing. |
| **7** | Demonstration on milling machine for generation of plane surfaces and use of end milling cutters. |
| **8** | Grinding of milling cutters and drills. |
| **9** | Exercise on cylindrical and surface grinders to machine surfaces as per drawing. |
| **10** | Cylindrical grinding using grinding attachment in a centre lathe |

**Course outcome**

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

**CO1:** Describe the geometry of single point cutting tool.

**CO2:** Explain milling machine , milling cutters , indexing head and prepare a job on milling machine .

**CO3:** Transform internal and external thread using lathe machine

**CO4:** Study capstan lathe and prepare job as per drawing

**CO5:** Practice of grinding of milling cutters and drills.

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | | | | | | | | |
| **CO2** | 3 | 3 | 2 | | | | | | | | | |
| **CO3** | 3 | 2 | | 2 | | | | | | | | |
| **CO4** | 3 | 3 | | 2 | | | | | | | | |
| **CO5** | 3 | 2 | | | | 2 | | | | | | |
| **Average** | **3.0** | **2.6** | **2.0** | **2.0** | | **2.0** | | | | | | |

# PIP230:THERMAL ENGINEERING LAB

**B.Tech. (P&IE) 4th Semester**
**0L+0T+2P**

| SN | NAME OF EXPERIMENT |
|---|---|
| 1 | Comparative study of<br>a) Four stroke diesel and petrol engines.<br>b) Two stroke petrol and diesel engines |
| 2 | Studies of fuel supply systems of diesel and petrol engines. |
| 3 | Study of cooling, lubrication and ignition system in diesel and petrol engines. |
| 4 | To study various types of Boilers and to study Boiler mounting and accessories. |
| 5 | To study various types of Dynamometers. |
| 6 | To study Multi Stage Air Compressors. |
| 7 | To find the BHP, Thermal efficiency of four stroke diesel engine. |
| 8 | Study of Brakes, Clutches, and Transmission System. |
| 9 | To prepare a comparison sheet of various automobiles (4 Wheeler and 2 Wheeler). |
| 10 | Study of parallel flow and counter flow heat exchanger. |
| 11 | Load test on Petrol Engine and Diesel engine. |
| 12 | Determination of conductivity of insulating powder. |
| 13 | Determination of effectiveness of parallel and counter flow heat exchanger. |

**Course outcome**

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

**CO1:** categorizing and demonstrating various engines and systems involved in automobiles

**CO2:** comparing the working of various boilers and their mountings

**CO3:** determine different parameters used in IC engines

**CO4:** discuss and identify the flow arrangements used in heat exchanger

**CO5:** evaluate the performance parameters of heat exchanger

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 1 | 1 | 2 | | | | | 2 | | | 2 | | |
| **CO2** | 2 | 2 | 2 | 2 | | 1 | | | 1 | | | 2 | | |
| **CO3** | 1 | 3 | 2 | 2 | 1 | 1 | | | 2 | | | 1 | | |
| **CO4** | 2 | 2 | 2 | 2 | 1 | | | | 1 | | | 2 | | |
| **CO5** | 1 | 3 | 2 | 2 | | | | | 2 | | | 1 | | |
| **Average** | **1.6** | **2.2** | **1.8** | **2.0** | **1.0** | **1.0** | | | **1.6** | | | **1.6** | | |

# PIP211: INDUSTRIAL ENGINEERING LAB-I.

**B.Tech. (P&IE) 5th Semester**
**0L+0T+2P**

| SN | SESSIONAL WORK | CONTACT HOURS |
|---|---|---|
| **1** | Case study on X bar charts and process capability analysis | |
| **2** | PChart:<br>(a)Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective.<br>(b) Plot a P-chart by taking a sample of n=20 and establish control limits | |
| **3** | To plot C-chart using given experimental setup | |
| **4** | Operating Characteristics Curve:<br>(a) Plot the operating characteristics curve for single sampling attribute plan for n = 20 ; c = 1 , 2 , 3 Designate the red ball to defective.<br>(b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution | |
| **5** | Distribution Verification:<br>(a) Verification of Normal Distribution.<br>(b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. Comment on your observations | |
| **6** | Verification of Poisson distribution | |
| **7** | Central Limit Theorem:<br>(a) To show that a sample means for a normal universe follow a normal distribution<br>(b) To show that the sample means for a non normal universe also follow a normal Distribution. | |
| **8** | Solve problems using available Statistical Process Control software in lab | |

CO1: Learn the statistical basics of control charts and sampling.
CO2: Construct the control charts, OC curves and evaluate the process performances.
CO3: Apply the SQC methods to problems using SPC software.

| Course Outcomes | P01 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1. | 3 | 3 | - | 3 | - | - | - | - | - | - | - | - |
| CO2. | 3 | 2 | - | 3 | - | - | - | - | - | - | - | - |
| CO3. | 3 | 3 | - | 3 | 2 | - | - | - | - | - | - | 2 |

# PIP231:FLUID MECHANICS LAB

**B.Tech. (P&I) 4TH Semester**
**0L+0T+2P**

| SN | NAME OF EXPERIMENT |
|---|---|
| 1 | Determination of Meta-centric height of a given body. |
| 2 | Determination of Cd, Cv & Cc for given orifice. |
| 3 | Calibration of contracted Rectangular Notch and / Triangular Notch and determination of flow rate. |
| 4 | Determination of velocity of water by Pitot tube. |
| 5 | Verification of Bernoulli's theorem. |
| 6 | Calibration and flow rate determination using Venturimeter & Orifice meter and Nozzle meter |
| 7 | Determination of head loss in given length of pipe. |
| 8 | Determination of the Reynold's number for laminar, turbulent and transient flow in pipe. |
| 9 | Determination of Coefficient for minor losses in pipes. |
| 10 | To study the velocity distribution in a pipe and also to compute the discharge by integrating the velocity profile. |
| 11 | To study the boundary layer velocity profile over a flat plate and to determine the boundary layer thickness. |

**Course outcome**

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

- **CO1:** develop procedure for standardization of experiments
- **CO2:** calibrate flow discharge measuring device used in pipes channels and tanks
- **CO3:** determine fluid and flow properties
- **CO4:** illustrate laminar and turbulent flows
- **CO5:** test the performance parameters for flow through pipes

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 3 | 2 | | | | | | | | |
| **CO2** | 3 | 3 | 2 | 3 | 3 | | | | | | | | |
| **CO3** | 3 | 3 | 2 | 3 | 3 | | | | | | | | |
| **CO4** | 3 | 2 | 2 | 3 | 2 | | | | | | | | |
| **CO5** | 3 | 3 | 2 | 3 | 2 | | | | | | | | |
| **Average** | **3.0** | **2.6** | **2.0** | **3.0** | **2.4** | | | | | | | | |

# PIL211: ADVANCED MANUFACTURING METHODS

**B.Tech. (P&I) 5th semester**

**3L+0T+0P**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | Introduction and classification of advanced machining process, consideration in process selection, difference between traditional and non-traditional process, Hybrid process. | 3 |
| II | **Abrasive finishing processes**: AFM, MAF (for Plain and cylindrical surfaces). | 4 |
| III | **Mechanical advanced machining process**: Introduction, Mechanics of metal removal, process principle, Advantages, disadvantages and applications of AJM,USM,WJC. | 5 |
| IV | **Thermo electric advanced machining process**: Introduction, Principle, process parameters,advantages, disadvantages and applications about EDM, EDG, | 4 |
| | LBM, PAM, EBM | 6 |
| V | **Electrochemical and chemical advanced machining process**: ECM, ECG, ESD, Chemical machining, | 5 |
| | Anode shape prediction and tool design for ECM process. Tool (cathode) design for ECM Process. | 3 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | Modern Machining Process, Pandey and Shan, Tata McGraw Hill | 1980 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | Advance Machining Process, Jain V.K., Allied Publishers Ltd. | 2002 |
| 2 | Non Traditional Manufacturing Process, Gary F. Bevedict, Marcel Dekker Inc New York. | 1987 |
| 3 | Non-Conventional Machining Process, Mishra P.K., Narosa Publishing House | 2006 |
| 4 | Non-Conventional Machining Process, J.A. McGeough | 1988 |
| 5 | Rapid Prototyping: principles and applications, Chee Kai Chua, Kah Fai Leong and Chu Sing Lim,2nd Edition, World Scientific | 2003 |
| 6 | Rapid Prototyping: Theory and Practice, Ali Kamrani, Emad Abouel Nasr and Springer; 1st Edition, | 2006 |

## P I L212: QUALITY MANAGEMENT

| | |
|---|---|
| **Credit: 3** | **Max. Marks: 150(IA:30, ETE:120)** |
| **3L+0T+0P** | **End Term Exam: 3 Hours** |

| SN | Contents | Hours |
|---|---|---|
| 1 | **Introduction:** Objective, scope and outcome of the course. | 01 |
| 2 | **Introduction to Quality Management**: Quality – Concept, Different Definitions and Dimensions, Inspection, Quality Control, Quality Assurance and Quality Management, Quality as Wining Strategy, Views of different Quality Gurus, Quality Cost. | 06 |
| 3 | **Process Quality Improvement:** Introduction to process quality, Graphical and statistical techniques for process Quality Improvement, Graphical tools for data representation, 7QC tools, Sampling, sampling distribution, and hypothesis Testing, Regression, control charts, process capability analysis, Measurement system analysis, Analysis of Variance(ANOVA), Design and analysis of experiment (DOE), Acceptance sampling pan, TQM | 9 |
| 4 | **Leadership,** Lean and JIT Q Quality Philosophy, Benchmarking, Process failure mode and effect analysis (PFMEA), Service Quality, Six sigma for process Improvement, ISO 9001, ISO 14000 and QS 9000, Quality audit, Quality Circles. | 9 |
| 5 | **Product Quality Improvement:** Quality Function Deployment, Robust Design and Taguchi Method | 08 |
| 6 | **Design Failure** Mode and Effect Analysis, Product Reliability Analysis, Six sigma in product development | 07 |
| | **Total** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | Introduction to Statistical Quality Control, Douglas C. Montgomery, 2nd Edition, Wiley. | 1991 |
| 2 | Fundamentals of Quality Control and Improvement, Amitava Mitra, 2nd Edition, Prentice Hall | 1998 |
| 3 | Quality Planning and Analysis, J.M.Juran and F.M. Gryna, McGraw Hill | |
| 4 | Quality Control, Dale H. Besterfield, 8th Edition, Pearson/Prentice Hall | 2008 |

| | | |
|---|---|---|
| **5** | Statistical Quality Control, E. L. Grant and Richard S. Leavenworth, Tata McGraw-Hill | 2000 |
| **6** | Design and Analysis of Experiments, 5th Edition, Douglas C. Montgomery, Wiley-India | 2007 |

# PIL213: MEASUREMENT & METROLOGY

**B.Tech. (P&IE) 5th semester**
**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Concept of measurement:** General concept of measurement, Need for measurement, Generalized measuring system, Units, Standards, Sensitivity, Readability, Range of accuracy, Precision, Accuracy Vs precision, Uncertainty. | 4 |
| | Repeatability and reproducibility, Errors in measurement, Types of error, Systematic and random error, Calibration, Interchangeability. | 3 |
| II | **Linear and angular measurements:** Linear measuring instruments: Vernier caliper, Micrometer, Slip gauges, Optical flat, Application of limit gauges; | 3 |
| | **Comparators**:- Mechanical comparators, Electrical comparator, Pneumatic comparator; | 2 |
| | Sine bar, Use of sine bar, Limitations of sine bars, Sources of error in sine bars, Bevel protractor, Applications of bevel protractor. | 4 |
| III | **Form measurement:** Introduction, Screw thread measurement, Thread gauges, Measurement of gears: Gear errors, Spur gear measurement, Parkinson gear tester. | 4 |
| | Surface finish measurement:-Introduction, Elements of surface texture, Analysis of surface finish, Methods of measuring surface finish, Straightness measurement, Flatness testing, Roundness measurements | 4 |
| IV | **Machine tool metrology**:Coordinate measuring machine (CMM):-Types of CMM, Features of CMM,Computer based inspection, Computer aided inspection using robots. | 5 |
| V | **Measurement of force**: Accelerometer, Load cells.<br>**Torque measurement:** Torque measurement using strain gauges, Torque measurement using torsion bars,<br>**Measurement of power**: Mechanical dynamometers, | 4 |
| | **Measurement of flow:** Variable area meters – rotameter, Hot wire anemometer, Pitot tube.<br>**Temperature measurement**: Thermocouples (Thermo electric effects), Thermistors, Pyrometers | 4 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | G.K. Vijayaraghavan & R. Rajappan, Engineering Metrology and Measurements, A.R.S. Publications, Chennai, Fourth Edition June | 2009 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | Mechanical Measurements , Beckwith T.G. ,N.L. Buck, and R.D. Marangoni , Addison Wesley | |
| 2 | Dimensional Metrology . Khare & Vajpayee, Oxford & IBH | |

| | | |
|---|---|---|
| **3** | Engineering Metrology, Jain R.K., Khanna Publishers | |
| **4** | Metrology & Precision Engineering , Scarr, McGraw Hill | |
| **5** | Handbook of Industrial Metrology, ASTME | |

**Course outcome**

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

**CO1:** Describe the basic concepts of measurement & measuring system.

**CO2:** Learn the various types of measuring instruments & their uses.

**CO3:** Identify & classify the measurement process for a particular application.

**CO4:** Apply the concepts for measuring the properties of the system.

**CO5:** Illustrate the measurement such as power, torque flow and temperature.

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | 3 | | | | | | | | | | | |
| **CO2** | 3 | 3 | 3 | 2 | | | | | | | | | | |
| **CO3** | 3 | 3 | 3 | 2 | | | | | | | | | | |
| **CO4** | 3 | 3 | 3 | 2 | | | | | | | | | | |
| **CO5** | 3 | 3 | | 2 | 1 | | | | | | | | | |
| **Average** | **3.0** | **3.0** | **3.0** | **2.0** | **1.0** | | | | | | | | | |

# PIL221: THEORY OF MACHINES

**B.Tech. (P&I) 5th semester**

**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Introduction to mechanism:** Basic concept of machines, links, kinematic pair, kinematic chain and mechanism. Inversions of kinematic chains: four bar chain mechanisms, quick return mechanisms, inversions of double slider crank mechanisms. | 5 |
| | **Velocity and acceleration in mechanism:** Velocity and acceleration polygons, relative velocity and instantaneous centre method | 3 |
| II | **Friction devices:** Types and laws of friction. Pivots and collars. Power screws such as lead screw of the lathe. | 4 |
| | **Clutches:** Single and multi-plate clutches.<br>**Brakes:** Band, block and band and block brakes. | 4 |
| III | **Gears:** Laws of gearing, gears terminology; tooth form; interference, undercutting and minimum number of teeth on pinion. Rack and pinion, Spur, helical, basic introduction of bevel, worm and worm gears,. | 6 |
| | **Gear Trains:** Simple, compound and epicyclic gear trains. | 3 |
| IV | **Cams:** Type of cams; displacement, velocity and acceleration curves for different cam followers; consideration of pressure angle and wear. | 4 |
| | **Gyroscope:** Principles of gyroscopic couple, effect of gyroscopic couple and centrifugal force on vehicles taking a turn, stabilization of ship. | 4 |
| V | **Balancing:** Balancing of rotating masses in same and different planes, balancing of reciprocating masses, swaying couple, hammer blow and tractive effort. | 7 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Rattan, S.S., "Theory of Machines", 2nd Ed., Tata McGraw Hill | 2006 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| **1** | Bevan, T., "Theory of Machines", Pearson Education. | 2013 |
| **2** | Uicker, J.J., Pennocle, G.R, and Shigley, J.E, "Theory of Machines and Mechanisms", 3rd Ed., Oxford University Press. | 2009 |
| **3** | Ambekar , A. G., "Mechanism And Machine Theory", Prentice-hall Of India | 2007 |
| **4** | Ghosh, A., "Theory of Mechanisms and Machines", Affiliated East West Press. | |
| **5** | Singh, S., "Theory of Machines", Pearson Education | 2013 |
| **6** | Stanisic., "Mechanisms and Machines-Kinematics, Dynamics & Synthesis", Cengageleasrning | 2014 |

## COURSE OUTCOME

| Course Name | Course Outcome | Details |
|---|---|---|
| THEORY OF MACHINES | CO1 | Learn the basic concept of machine and different mechanism & sketch velocity and acceleration diagrams. |
| | CO2 | Apply the concept of friction in brakes, clutches and dyanamometers. |
| | CO3 | Identify appropriate gear and gear train for particular applications. |
| | CO4 | Explain the gyroscopic effect. Construct/sketch the cam profile for different follower motion. |
| | CO5 | Solve problems of balancing of rotating and reciprocating masses. |

## CO-PO MAPPING

| | Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| THEORY OF MACHINES | CO1 | 2 | 3 | 2 | 2 | | | | | | | | |
| | CO2 | 3 | 3 | 2 | 2 | | | | | | | | |
| | CO3 | 2 | 3 | 2 | 2 | | | | | | | | |
| | CO4 | 3 | 3 | 2 | 2 | | | | | | | | |
| | CO5 | 2 | 3 | 2 | 2 | | | | | | | | |
| | Average | 2.4 | 3 | 2 | 2 | | | | | | | | |

# PIL317: NON DESTRUCTIVE TESTING

**B.Tech. (P&I) 5th semester**
**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Introduction**: An Overview, Factors influencing the Reliability of NDE, Defects in materials, Defects in composites. NDT methods used for evaluation of materials and composites. | 3 |
| | **Visual Inspection:** Basic Principle and Applications. | 2 |
| | **Liquid Penetrant Testing:** Principle, Procedure and Test Parameters, Materials, Limitations and Applications. | 3 |
| II | **Radiographic Inspection:** Principles of X – ray radiography, equipment, Absorption, Scattering, X-ray film processing, General radiographic procedures, Reading and Interpretation of Radiographs, Industrial radiographic practice, Limitations and Applications, Welding defects detection. Gamma ray radiography. | 8 |
| III | **Ultrasonic Testing:** Principle of wave propagation, Ultrasonic equipment, Variables affecting an ultrasound test, Basic methods: Pulse Echo and Through Transmission, Types of scanning. | 5 |
| | **Applications of UT:** Testing of products, Welding Inspection, Tube Inspection, Thickness Measurement, Elastic Constant Determination, Ultrasonic testing of composites. | 3 |
| IV | **Magnetic Particle Inspection:** Methods of generating magnetic field, Demagnetization of materials, Magnetic particle test: Principle, Test Equipment and Procedure, Interpretation and evaluation. | 5 |
| | **Introduction to Accostic Emission Testing and Thermography.** | 3 |
| V | **Eddy Current Testing:** Principle of eddy current, Factors affecting eddy currents, Test system and test arrangement, Standardization and calibration, Application and effectiveness. | 5 |
| | Comparison and Selection of NDT Methods, Codes and Standards | 3 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | Baldev Raj, T. Jay Kumar, M. Thavasimuthu,Practical Non-Destructive Testing, Narosa. | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | Loius Cartz, Non Destructive Testing, ASM International | 1995 |
| 2 | J PRASAD, C G K NAIR, NDT & Evaluation Of Materials, TMH | 2008 |
| 3 | R. Halmshaw, Introduction to the Non-Destructive Testing of Welded Joints, | 1997 |
| 4 | American Metals Society, Non-Destructive Examination and Quality Control, Metals Hand Book, Vol.17, 9th Ed. | 1989 |

# PIL331: AUTOMOBILE ENGINEERING

**B.Tech. (P&IE) 5th semester**
**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Frame & Body:** Layout of chassis, types of chassis frames and bodies, their constructional features and materials. | 3 |
| | **Clutches:** single plate, multi-plate, cone clutch, semi centrifugal, electromagnetic, vacuum and hydraulic clutches. Fluid coupling.<br>**Brakes:** Classification and function; Mechanical, hydraulic, vacuum air and self engineering brakes; Brake shoes and lining materials. | 5 |
| II | **Gear Boxes**: Sliding mesh, constant mesh, synchromesh and epicyclic gear boxes, Automatic transmission system; Hydraulic torque converter | 4 |
| | **Drives**: Overdrive, Propeller shaft, Universal joints, Differential; Rear axle drives. Hotchkiss and torque tube drives; Rear axle types; Front wheel and All wheel drive. | 4 |
| III | **Wheels and Tyres**:Tyre types, Tyre construction; Tyre inflation pressure, Tyre wear and their causes; Re-treading of the tyre, | 2 |
| | **Steering system:** steering gear boxes, Steering linkages, Steering mechanism, Under and Over steering. Steering Geometry, Effect of camber, caster, king pin inclination, toe in and toe out; Power steering; Integral and linkage types | 3 |
| | **Suspension system:** objective and requirements, Suspension spring, front and rear suspension systems, Independent suspension system Shock absorbers. | 3 |
| IV | **Automotive Electrical System:** Battery construction, Charging and testing, battery types, Starting and Battery Charging System: Starter motor construction, types of drive, Alternator construction, regulation and rectification. | 4 |
| | **Ignition System:** Magneto and coil ignition systems, System components and requirements, Automotive lighting: Wiring systems Electrical instruments; head lamp, electric horn, fuel level indicator. | 4 |
| V | **Automotive Air Conditioning:** Introduction, Loads, Air conditioning system Components, Refrigerants, Fault Diagnosis. | 4 |
| | **Automotive Safety:** Safety requirements, Safety Devices, Air bags, belts, radio ranging, NVS (Night Vision System) GPS (Global Positioning System) | 4 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | RP SHARMA,A Course in Automobile Engineering,Dhanpat Rai & Sons | |
| 2 | P S Gill,A Text book of Automobile Engineering,KATSON Books VOL 1&2 | 2010 |
| 3 | Kirpal Singh,Automobile Engineering, Standard | 2003 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | R K Rajpoot,A Text book of Automobile Engineering,Laxmi Publications | 2007 |
| 2 | Jornsen Reimpell, Helmut Stoll,The Automotive Chassis: Engineering Principles,Jurgen Betzler (P) Ltd, | 2001 |

# PIP212 : QUALITY CONTROL LAB

**B.Tech. (P&IE) 5th Semester**
**0L+0T+2P**

| SN | NAME OF EXPERIMENT |
|---|---|
| **1** | Case study on X bar charts and process capability analysis |
| **2** | PChart:<br>(a)Verify the Binomial Distribution of the number of defective balls by treating the balls with a red colour to be defective.<br>(b) Plot a P-chart by taking a sample of n=20 and establish control limits |
| **3** | To plot C-chart using given experimental setup |
| **4** | Operating Characteristics Curve:<br>(a) Plot the operating characteristics curve for single sampling attribute plan for n = 20 ; c = 1 , 2 , 3 Designate the red ball to defective.<br>(b) Compare the actual O.C. curve with theoretical O.C. curve using approximation for the nature of distribution |
| **5** | Distribution Verification:<br>(a) Verification of Normal Distribution.<br>(b) To find the distribution of numbered cardboard chips by random drawing one at a time with replacement. Make 25 subgroups in size 5 and 10 find the type of distribution of sample average in each case. Comment on your observations |
| **6** | Verification of Poisson distribution |
| **7** | Central Limit Theorem:<br>(a) To show that a sample means for a normal universe follow a normal distribution.<br>(b) To show that the sample means for a non normal universe also follow a normal Distribution. |

# PIP213: METROLOGY LAB

**B.Tech. (P&IE) 5th Semester**
**0L+0T+2P**

| SN | NAME OF EXPERIMENT |
|---|---|
| **1** | Study of various measuring tools like dial gauge, micrometer, vernier caliper and telescopic gauges. |
| **2** | Measurement of angle and width of a V-groove by using bevel protector.. |
| **3** | To measure a gap by using slip gauges |
| **4** | Measurement of angle by using sine bar. |
| **5** | Study and use of surface roughness instrument (Taylor Hobson make) Inspection of various elements of screw thread by Tool makers microscope and optical projector. |
| **6** | Measurement of gear tooth thickness by using gear tooth vernier caliper. |
| **7** | To check accuracy of gear profile with the help of profile projector. |
| **8** | To determine the effective diameter of external thread by using three-wire method. |
| **9** | To measure flatness and surface defects in the given test piece with the help of monochromatic check light and optical flat. |
| **10** | To plot the composite errors of a given set of gears using composite gear tester. |
| **11** | Measurement of coating thickness on electroplated part and paint coating on steel and non-ferrous material using coating thickness gauge. |
| **12** | Study and use of hardness tester for rubber and plastics. |
| **13** | To check the accuracy of a ground, machined and lapped surface - (a) Flat surface (b) Cylindrical surface. |
| **14** | To compare & access the method of small-bore measurement with the aid of spheres. |

**Course outcome**

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

**CO1:** To define the concept of metrology and measuring instruments.

**CO2:** Classify and know the uses of measuring instruments

**CO3:** To observe and interpret the use of slip gause to build required dimension.

**CO4:** To measure the angle by using sine bar and bevel protector and use of combination set.

**CO5:** Demonstrate and use of profile projector to check dimensions.

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | 3 | | | | | | | | | |
| **CO2** | 3 | 3 | | 1 | 3 | | | | | | | | | |
| **CO3** | 3 | 2 | | 1 | 2 | | | | | | | | | |
| **CO4** | 3 | 3 | | | 2 | | | | | | | | | |
| **CO5** | 3 | | | | 3 | | | | | | | | | |
| **Average** | **3.0** | **2.5** | **1.0** | **1.0** | **2.6** | | | | | | | | | |

## PIP221: THEORY OF MACHINES LAB.

**B.Tech. (P&I) 5th Semester**
**0L+0T+2P**

| SN | NAME OF EXPERIMENT |
|---|---|
| 1 | To study inversions of four bar chain and slider crank mechanism and their practical applications. |
| 2 | To study Steering Mechanisms: Davis and Ackerman. |
| 3 | Study of quick return mechanism and its practical applications. |
| 4 | Study of inversion of Double slider chain: Oldham Coupling, Scotch Yoke and Elliptical Trammel. |
| 6 | Study of various cam-follower arrangements. To plot displacement v/s angle of rotation curve for various cams |
| 7 | To determine co-efficient of friction using two roller oscillating arrangement. |
| 8 | Study of various types of dynamometers, Brakes and Clutches. |
| 9 | Study of differential gear box. |
| 13 | To verify the torque relation for gyroscope. |
| 16 | To perform wheel balancing. To perform static and dynamic balancing on balancing set up. |
| 19 | Study of a lathe gear box, sliding mesh automobile gear box, planetary gear box. |

## COURSE OUTCOME

| Course Code | Course Name | Course Outcome | Details |
|---|---|---|---|
| 4PIU9 | THEORY OF MACHINES LAB | CO1 | To plot various performance curves of the machine elements |
| | | CO2 | To perform different balancing operations |
| | | CO3 | To determine the various operating parameters of oscillating machines |
| | | CO4 | To study the gear operated systems |

## CO-PO MAPPING

| | Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| THEORY OF MACHINES LAB | CO1 | 3 | 3 | 1 | 3 | | | | | | | | |
| | CO2 | 3 | 3 | 1 | 2 | | | | | | | | |
| | CO3 | 3 | 3 | 1 | 3 | | | | | | | | |
| | CO4 | 3 | 1 | 1 | 2 | | | | | | | | |
| | Average | 3 | 2.5 | 1 | 2.5 | | | | | | | | |

## PIP312: INDUSTRIAL ENGINEERING LAB-II

**B.Tech. (P&IE) 5th Semester** **Max. Marks: 75**
**0L+0T+2P** **Exam Hours: 2**

| SN | NAME OF EXPERIMENT | CONTACT HOURS |
|---|---|---|
| **1** | Determination of time standard for a given job using stopwatch time-study. | |
| **2** | Preparation of flow process chart, operation process chart and man-machine charts for an existing setup and development of an improved process. | |
| **3** | Study of existing layout of a workstation with respect to controls and displays and suggesting improved design from ergonomic viewpoint. | |
| **4** | To carry out a work sampling study. | |
| **5** | To conduct process capability study for a machine in the workshop. | |
| **6** | To design a sampling scheme based on OC curve. | |
| **7** | To conduct Shewart's experiments on known population | |
| **8** | Generation of random numbers for system simulation such as facility planning, job shop scheduling etc. | |

# PIL310: TOOL ENGINEERING

**B.Tech. (P&I) 6th semester**
**3L+1T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | Introduction, properties of tool material, types of tool material, | 5 |
| | basic requirement of tool material and general consideration in tool design. | 3 |
| II | Design of material-cutting tool: Single point tools, basic principles of multiple point tools, Linear-Travel tools (Broach), | 4 |
| | Axial Feed Rotary Tools (Drill), Milling Cutters. | 3 |
| III | Introduction to press, Press accessories, Die design fundamentals, Strip layout, | 4 |
| | Blanking and piercing Dies, Combination Dies (compound & progressive die). | 4 |
| IV | Design of Bending Dies, | 3 |
| | Design of Drawing and Deep drawing dies. | 5 |
| V | Introduction to Jig & Fixtures, usefulness, Principles of Jig & Fixtures design, Principle of location, Locating and Clamping devices. | 4 |
| | Basic construction principle, Drilling jigs, Brief introduction about Milling fixtures, Grinding fixtures, Broaching and Lathe fixtures. | 5 |
| | **TOTAL** | **40** |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Rao, P.N. "Manufacturing Technology" vol.I, Tata McGraw Hill Ltd | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | |
| **1** | Tool design by Donaldson | |
| **2** | Tool design by ASTME | |
| **3** | Metal Cutting Theory and Cutting Tool Design, Arshinov & Acherken, MTR Publishers | |
| **4** | Machine Tool Design, Acherken, MIR Publishers | |
| **5** | Principles of Machine Tools, Sen & Bhattacharya, New Central Book Agency | |
| **6** | Principles of Metal Cutting, Shaw,M.C., Oxford & IBH | |
| **7** | Fundamentals of Tool Engineering Design, Basu, Mukhopadhyay & Mishra, Oxford & IBH | |

**Course outcome**

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

- **CO1:** Learn about materials properties of tool.
- **CO2:** Evaluate different types of cutting tools
- **CO3:** Describe the principles of Jig and fixtures.
- **CO4:** Design of various dies used in manufacturing.
- **CO5:** Review Press and Press working practices

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CO1** | 3 | | | | | | 1 |
| **CO2** | 3 | 3 | 2 | 2 | | 1 | 1 |
| **CO3** | 3 | 3 | | | | 1 | 1 |
| **CO4** | 3 | 2 | 2 | 2 | | 1 | 1 |
| **CO5** | 3 | 2 | | 1 | | 1 | 1 |
| **Average** | **3.0** | **2.5** | **2.0** | **1.7** | | **1.0** | **1.0** |

# PIL311: OPERATIONS RESEARCH

**B.Tech. (P&I) 6th semester**

**3L+0T**

| Unit | Contents | Contact hours |
|---|---|---|
| I | **Overview of Operations Research** | 1 |
| | **Linear Programming**: Applications and model formulation, Graphical method, Simplex method, duality and Sensitivity analysis. | 4 |
| | Transportation Model and Assignment Model including travelling salesman problem. | 4 |
| II | **Integer Linear Programming:** Enumeration and cutting Plane solution concept, Gomory's all integer cutting plane method, Branch and Bound Algorithms, applications of zero-one integer programming. | 5 |
| | **Replacement Models:** Capital equipment replacement with time, group replacement of items subjected to total failure. | 3 |
| III | **Queuing Theory**: Analysis of the following queues with Poisson pattern of arrival and exponentially distributed service times, Single channel queue with infinite customer population, Multichannel queue with infinite customer population, | 3 |
| | **Competitive Situations and Solutions**: Game theory, two person zero sum game, saddle point, minimax (maximin) method of optimal strategies, value of the game. Solution of games with saddle points, dominance principle. Rectangular games without saddle point – mixed strategy, approximate solution, and simplified analysis for other competitive situations. Application of linear programming | 4 |
| IV | Theory of Decision making: Decision making under certainty, risk and uncertainty. Decision trees. | 5 |
| | **Deterministic Inventory control models:** functional role of inventory, inventory costs, model building, Single item inventory control model without shortages, with shortage and quantity discount. Inventory control model with uncertain demand, service level, safety stock, P and Q systems, two bin system. Single period model. Selective Inventory control techniques. | 4 |
| V | **Probabilistic Inventory control models:** Instantaneous demand without setup cost and with setup cost, Continuous demand without setup cost | 4 |
| | **Simulation**: Need of simulation, advantages and disadvantages of simulation method of simulation. Generation of Random numbers, Generation of Normal Random numbers. Use of random numbers for system simulation. , Monte Carlo simulation, simulation language ARENA, Application of simulation for solving queuing Inventory Maintenance, Scheduling and other industrial problems | 4 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | Operations Research, Ravindran, Phillips and Solberg, Wiley India. | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | Introduction to Operations Research, Hillier F.S. and Lieberman G.J., CBS Publishers. | 2002 |
| 2 | Operations Research, Taha H.A., Pearson Education | 2012 |
| 3 | Linear Programming and Network Flows, Bazaraa, Jarvis and Sherali, Wiley India. | 2003 |
| 4 | Principles of Operations Research, Wagner H.M., Prentice Hall of India. | 2001 |
| 5 | Operations Research, Gupta and Heera, S. Chand Publications. | 2008 |

**Course outcome**

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

**CO1:** Discuss the concepts of operations research modelling approaches by formulating and solving engineering and managerial situations as LPP

**CO2:** Evaluate engineering and managerial situations as Transportation and Assignment problems.

**CO3:** Explain game and queuing theories.

**CO4:** Illustrate decision theory and estimate inventory management policy

**CO5:** Simulate and analyze engineering and managerial problems.

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | | | | | | | | | | |
| **CO1** | 3 | 3 | 2 | 1 | 1 | | | | | | | |
| **CO2** | 3 | 3 | 3 | 3 | 2 | | | | | | | |
| **CO3** | 3 | 3 | 3 | 2 | 2 | | | | | | | |
| **CO4** | 3 | 3 | 3 | 1 | 2 | | | | | | | |
| **CO5** | 3 | 3 | 3 | 3 | 3 | | | | | | | |
| | | | | **Average** | | **3.0** | **3.0** | **2.8** | **2.0** | **2.0** | | |

# PIL312 : FACILITIES PLANNING

**B.Tech. (P&I) 6th Semester**
**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | Definition of facilities planning, significance and objectives of facilities planning. Process of facilities planning. Strategic facilities planning. | 5 |
| | Product selection, Review of various types of manufacturing processes and Process selection. | 3 |
| II | Facility Location: Need for location decisions, location factors, location analysis: Qualitative methods: subjective, equal weight, variable weight, factor point rating and composite measure method. | 4 |
| | Quantitative methods: location breakeven analysis, median model, gravity model, Brown and Gibson method, single facility location models, minmax location problem, Location allocation models, Bridgeman's Dimensional Analysis. | 4 |
| III | Facility Layout: Importance and function, objectives and advantages of good layout, types of plant layout problems. Basic layout types: Product, Process, Group and fixed position layout. Plant layout factors, Layout procedure, Systematic layout planning procedure, Flow and activity analysis, Process charts, flow diagram, Travel chart, activity relationship chart, and Relationship diagram. Evaluation and implementation of layout. Industrial buildings, influence of building on layout. | 4 |
| | Computer aided layout: CRAFT, CORELAP, COFAD, ALDEP, PLANET. | 4 |
| IV | Production and assembly line balancing - various operational research techniques for balancing of assembly line and fabrication line. | 5 |
| | Material Handling: Principles of material handling, materials handling system design. Systematic handling analysis, Unit loads. Computer Aided Material Handling. | 3 |
| V | Material Handling Equipment: Conveyors, monorail, hoists and Cranes; automated storage and retrieval systems (AS/RS) , Industrial trucks, Containers and supports, Auxiliary and other equipments | 5 |
| | Receiving and shipping, storage and warehousing; Equipment planning, layout planning. | 3 |
| | **TOTAL** | **40** |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Facilities Planning, Tomphins James A & White John A, John Wiley & Sons | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| **1** | Facility Layout & Location, Francis R.C. & White J.A. Prentice Hall. | **2002** |
| **2** | Material Handling, Immer, McGraw Hill | **2009** |
| **3** | Practical Plant Layout, Muther , McGraw Hill | **1998** |
| **4** | Plant Layout & Design , Immer , McGraw Hill | **2004** |

**Course outcome**

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

**CO1:** Explain the objectives of facilities planning and compare various types of manufacturing processes

**CO2:** Classify location factors and relate quantitative factors for decision making in location planning

**CO3:** Explain various layout types and construct plant layout using systematic layout planning

**CO4:** Apply computer aided layout techniques.

**CO5:** Solve line balancing problems using operations research techniques.

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PSO1 | PSO2 | | | | | | | | | | |
| **CO1** | 3 | 2 | 1 | | | | | | | | | |
| **CO2** | 2 | 3 | 2 | 3 | 3 | | | | | | | |
| **CO3** | 3 | 2 | 2 | 3 | 2 | | | | 2 | 3 | | |
| **CO4** | 2 | 3 | 2 | 2 | 3 | | | | | | | |
| **CO5** | 2 | 2 | 3 | 1 | 2 | | | | | | | |
| **Average** | **2.4** | **2.4** | **2.0** | **2.3** | **2.5** | | | | **2.0** | **3.0** | | |

# PIL313: SUPPLY AND OPERATIONS MANAGEMENT

**B.Tech. (Mechanical) 6th semester** **Max. Marks: 150**

**3L+0T** **Exam Hours: 3**

| Unit | Contents | Contact Hours |
|---|---|---|
| I | Introduction to operations management (OM), the scope of OM; Historical evolution of OM; Trends in business; the management process. Operations Strategy, Competitiveness and Productivity | 3 |
| | Demand Forecasting: components of forecasting demand, Approaches to forecasting: forecasts based on judgment and opinion, Time series data. Associative forecasting techniques, Accuracy and control of forecasts, Selection of forecasting technique. | 4 |
| II | Product and Service design, Process selection, Process types, Product and process matrix, Process analysis. | 3 |
| | Capacity Planning: Defining and measuring capacity, determinants of effective capacity, capacity strategy, steps in capacity planning process, determining capacity requirements, Capacity alternatives, Evaluation of alternatives; Cost Volume analysis. | 2 |
| III | Facility Location: Need for location decisions, factors affecting location, qualitative and quantitative techniques of location. Facilities layout: Product, Process, Fixed position, combination and cellular layouts; line balancing. Material Handling | 4 |
| | Planning levels: long range, Intermediate range and Short range planning, Aggregate planning: Objective, Strategies, and techniques of aggregate planning. Master scheduling; Bill of materials, MRP; inputs processing and outputs, and overview of MRPII , use of MRP to assist in planning capacity requirements, Introduction to ERP | 4 |
| IV | Techniques of production control in job shop production, batch production and mass production systems. sequencing: priority rules, sequencing jobs through two work centers, scheduling services | 4 |
| | Introduction to Just-in-time (JIT) and Lean Operations: JIT production, JIT scheduling, synchronous production, Lean operations system | 4 |
| V | Supply Chain Management (SCM): Need of SCM, Bullwhip effect, Elements of SCM, Logistics steps in creating effective supply chain, Purchasing and supplied management. | 3 |
| | **Project Management:** Nature of projects, project life cycle, Work breakdown structure, PERT and CPM, Time-Cost trade-offs: Crashing. Resource allocation, leveling | 5 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Stevenson, Operations Management, Tata McGraw Hill. | 2009 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub.** |
| **1** | Roberta S. Russell, Bernard W. Taylor, Operations Management, John Wiley | 2010 |
| **2** | Joseph S. Martinich, Production And Operations Management, John Wiley | 2008 |
| **3** | S.N. Chary, Production and Operations Management, Tata McGraw Hill | 2009 |
| **4** | Norman Gaither, Greg Frazier, Operations Management, Thomson Learning | 2002 |

CO1: **Describe** the basic concepts of operations management and production systems
CO2: **Analyse** and **solve** the problems of production planning, scheduling & control.
CO3: **Understand** the concepts of MRP, JIT and SCM.
CO4: **Solve** the problems using project management & reliability.

| Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 1 | 1 | 2 | | | | | | | | | |
| C02 | 1 | 3 | 3 | 3 | | | | | | | | |
| C03 | 1 | 3 | 3 | 3 | 2 | - | - | - | - | - | - | - |
| C04 | 1 | 1 | 2 | 3 | 1 | - | - | - | - | - | - | - |

# PIL314: CNC MACHINES AND PROGRAMMING

**B.Tech. (P&IE) 5th semester**
**4L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| **I** | Introduction: Definition of NC, Applications of NC, Historical Developments in Automation, Classification of NC Systems, Comparison of NC and Conventional Machines, Advantages of NC | **8** |
| **II** | NC Hardware: Architecture of NC Systems, Design Considerations, Mechanical Elements, Structure, Guideways and Slides, Guideway Elements, Transmission Systems, Spindle Unit, Coolant system, Lubrication System, Tool and work Changing Mechanisms, Electrical Elements, Drives, Sensors, Control Loops, Computing Elements/ Firmware, Interpolators | **8** |
| **III** | NC Software: Introduction, Manual Part Programming, Computer-Assisted Part Programming, Language Based , Geometric Modeling Based, Automatic Part Program Generation, | **4** |
| **IV** | CAPP Systems, 5 Axis Programming, Post-Processing, Programming Robots and CMMs | **4** |
| | NC Simulation, Kinematic simulation, Volumetric simulation, Applications of Volumetric NC Simulation, Verification | **4** |
| **V** | Advanced Topics:, Adaptive Control, Off-line adaptive control, Various optimization criteria, Hardware Based AC, Software Based AC, Tooling and Instruments for NC Special, Rapid Product Development, CAM, FMS, CIM | **4** |
| | **TOTAL** | **32** |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Krar S. and Gill A., CNC: Technology and Programming, McGraw Hill | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | |
| **1** | Koren Y., Computer Control of Manufacturing Systems, Tata McGraw Hill. | |
| **2** | Michael Fitzpatrick, Machining and CNC Technology, McGraw Hill Education | |
| **3** | Jones B.L.,Introduction to Computer Numerical Control, John Wiley & Sons. | |
| **4** | Kral I.H., , Numerical Control Programming in APT, Prentice-Hall | |
| **5** | Chang C.H. and Melkanoff M.A., ,NC Machine Programming and Software Design, Prentice-Hall | |

**Course outcome**

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

**CO1:** Implementation and Examine applications and advantages of CNC machines and technology.

**CO2:** Recognize about the CNC machine tool Structure.

**CO3:** Knowledge of basic programming codes and calculation of CNC Machining Parameters.

**CO4:** Preparation of CNC program for CNC Lathe & Milling

**CO5:** Demonstrate and verify NC softwareβ€™s, Sensors, NC modeling & Simulation and Robotics.

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 1 | | | | | | | | | | | | |
| **CO2** | 3 | 1 | | 2 | | | | | | 2 | | | | |
| **CO3** | 3 | 3 | 2 | 3 | | | | | | 2 | | | | |
| **CO4** | 3 | 3 | 3 | 3 | | | | | | 2 | | | | |
| **CO5** | 3 | 3 | 3 | 3 | | | | | | 2 | | | | |
| **Average** | **3.0** | **2.2** | **2.7** | **2.8** | | | | | | **2.0** | | | | |

## PIL321: COMPUTER AIDED DESIGN AND GRAPHICS

**B.Tech. (Mechanical) 6th semester**

**4L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Overview of Computer Graphics:** Picture representation, Coordinate Systems, Raster Scan Display, DDA for line generation and Bresenham's algorithm for line and circle generation; Graphics standards: GKS, IGES, STEP, DXF.. | 5 |
| | **Parametric representation of plane curves:** line, circle, ellipse, parabola and hyperbola. | 5 |
| II | **Parametric representation of Space Curves:** Cubic spline curve, Bezier Curve and B Spline Curves. Blending of Curves. | 6 |
| | **Parametric representation of Surfaces:** HermiteBicubic surfaces, Bezier surfaces and B-spline surfaces. | 5 |
| III | **Solid Representation:** B-rep. and CSG. Comparison between three types of models. | 9 |
| IV | **Two and Three Dimensional Transformation of Geometric Models:** Translation, Scaling Reflection, Rotation and Shearing, Homogeneous Representation, Combined Transformation. | 4 |
| | **Projection of Geometric models**: Parallel and Perspective Projection. | 6 |
| V | **Clipping:** Point clipping, Line clipping, Cohen- Sutherland algorithm etc., Viewing transformation. | 4 |
| | **Hidden line and surface removal**: Techniques and Algorithms. Coloring and Shading. | 6 |
| | **TOTAL** | **50** |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Zeid and Sivasubramanian,CAD/CAM: Theory and Practice, Tata McGraw Hill | |
| **2** | Rogers and Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| **1** | Rao P.N., CAD / CAM Principles and Applications, McGraw Hill. | **2004** |
| **2** | Pao Y.C., Elements of Computer Aided Design and Manufacturing, John Wiley and Sons. | **1984** |
| **3** | Alavala C.R., CAD/CAM: Concepts and Applications, Prentice Hall of India. | **2008** |
| **4** | Xiang and Plastock, Computer Graphics, Schaum's Outlines, Tata McGraw Hill. | **2007** |

| Course outcome |
|---|
| **At the end of the course, the student will be able to** |
| **CO1:**Explain various aspects of picture representation on the display device and model the plane curves in parametric representation. |
| **CO2:**Develop different geometries from the curve and surface entities usingparametric representation. |
| **CO3:**Develop solid models using B-rep and CSG. |
| **CO4:**Apply geometric transformation and projection on geometric models to get the desired display. |
| **CO5:**Make use of algorithms for clipping and hidden line/surface removal. |

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 3 | 1 | 2 | | | | | | | |
| **CO2** | 3 | 3 | 3 | 1 | 2 | | | | | | | 2 |
| **CO3** | 3 | 3 | 3 | 1 | 2 | | | | | | | 2 |
| **CO4** | 3 | 2 | 3 | 1 | 2 | | | | | | | |
| **CO5** | 3 | 2 | 3 | 1 | 2 | | | | | | | |
| **Average** | **3.0** | **2.4** | **3.0** | **1.0** | **2.0** | | | | | | | **2.0** |

# PIL330: STEAM ENGINEERING AND POWER PLANT

**B.Tech. (Mechanical) 6th Semester**

**4L+0T**

| Unit | Contents | Contact hours |
|---|---|---|
| I | **Steam generators:** Classification of Boilers, water and fire tube boilers, High pressure boilers, Advantages of high pr. Boilers, Natural and forced circulation boilers, Water wall. | 4 |
| | Steam drum internal, steam super heaters, Economizers, air preheater, induced, forced and balanced draught boilers, Fluidized bed boilers | 4 |
| II | Definition and type of nozzle and diffuser equation of continuity, sonic velocity, mach no. and stagnation properties, the steady flow energy equation for nozzles, momentum energy equation for flow through steam nozzles nozzle efficiency, effect of friction, nozzle for uniform pressure drop, throat pressure for maximum discharge or chock flow, critical pressure ratio, design of nozzle and diffuser. | 8 |
| III | **Steam Turbines:** Principle and working of steam turbines, type of turbines, compounding for pressure and velocity. Overview and difference of various type of turbine, different types of governing of turbines. | 3 |
| | **Impulse turbine:** The effect of blade friction on velocity diagram. Force, work and power, Blade or diagram efficiency, Gross stage efficiency, steam speed to blade, speed ratio for optimum performance, turbine performance at various loads | 5 |
| IV | **Impulse reaction turbine:** Velocity diagram and work done, degree of reaction, Parson turbine, blade efficiency, gross stage efficiency comparison of enthalpy drop in various stages, size of blades in impulse reaction turbines for various stages of impulse reaction and impulse turbine. | 5 |
| | **Regenerative Feed Heating Cycles**: Introduction, Ideal regenerative feed heating cycle, Regenerative heating cycles and their representation on T-s and h-s Diagram, Representation of actual process on T-s andh-s Diagram Regenerative cycles, types of feed heating arrangements, Optimum feed water temperature and saving in Heat Rate. direct contact and surface heaters. | 4 |
| V | **Reheating of steam**: Practical reheating and Non- reheating cycles, advantage and disadvantages of reheating, reheat regenerative cycle, regenerative water extraction cycles. | 4 |
| | Process heat and by product power cycle, pass out turbine, Binary vapour cycle. Condensers. | 3 |
| | | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | Steam, Gas Turbine and Power Plant Engineering, Yadav R., CPH Allahabad | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub.** |
| 1 | A Practical Guide to Steam Turbine, Heinz P. Bloch, McGraw Hill Publication | 1995 |
| 2 | Steam Turbines: Design Application and Rerating, Heinz P. Bloch, McGraw Hill | 1996 |
| 3 | Steam Turbine: Theory and Design, Shlykhin P., University press of Pacific. | 2006 |
| 4 | Steam Turbine: Theory and Construction, Wilde and Salter, Merchant Books. | 2007 |
| 5 | Power Plant Engineering, Nag P.K., Tata McGraw-Hill, New Delhi. | 1992 |
| 6 | Thermal Science & Engineering, Kumar D.S., S.K.Kataria & Sons | 2006 |
| 7 | Engineering Thermodynamics, Nag P.K., Tata McGraw Hill, New Delhi | 1998 |
| 8 | Fundamentals of Classical Thermodynamics, G J Van Wylen, Willey Eastern | 1959 |
| 9 | Engineering Thermodynamics, Cengel & Boles, Tata McGraw-Hill, New Delhi. | 2006 |
| 10 | Engineering Thermodynamics, Chottopadhyay P., Oxford University Press. | 2009 |

CO1: Learn about the economics of power plants.
CO2: Learn about site selection and the working cycles of different power plants.
CO3: Learn how to analyze and compare the performance of various power plants.
CO4: Students learns and apply general theories of renewable energy to improve power generation.

| Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - |
| C02 | 3 | 3 | 2 | - | - | - | - | - | - | - | - | - |
| C03 | 3 | 3 | 2 | - | - | | | - | - | - | - | |
| CO4 | 3 | 3 | 2 | | | | | | | | | |

# PIP220: MACHINE TOOL DESIGN SESSIONAL

**B.Tech. (P&I) 5th Semester** **Max. Marks: 75**
**0L+0T+2P** **Exam Hours: 3**

| SN | SESSIONAL WORK |
|---|---|
| 1 | Functional requirements of machine tools. |
| 2 | Working and auxiliary motions in machine tools. |
| 3 | Design criterion for machine tool structure, Static & dynamic stiffness. |
| 4 | Function & important requirements of spindle unit. |
| 5 | Importance of machine tool compliance with respect to machine tool accuracy. |
| 6 | Application and sketching of Slider-crank mechanism, Cam mechanism, Rack & pinion mechanism, Nut & screw mechanism, Ratchet gear mechanism, Geneva mechanism, Reversing mechanism, Differential mechanism, Norton mechanism, Mender's mechanism. |
| 7 | Aim of speed & feed rate regulation, stepped regulation of speed. |
| 8 | G.P. series is used in steeped regulation of speed. |
| 9 | Design a four / six speed Gear Box. |
| 10 | Design of Lathe bed. (including Torque analysis of lathe bed, bending of lathe bed, designing for torsional rigidity, use of reinforcing stiffener in lathe bed) |
| 11 | Analysis of force under headstock, tail stock and saddle. |
| 12 | Design of Guide ways / Slide ways. |
| 13 | Estimation of power requirements and selection of motor for metal cutting machine tool spindles. |

# PIP310: METAL CUTTING LAB.

**B.Tech. (P&I) 6th Semester**
**0L+0T+3P**

| SN | NAME OF EXPERIMENT |
|---|---|
| 1 | Find out Chip reduction co-efficient (reciprocal of chip thickness ratio) during single point turning. |
| 2 | Forces measurements during orthogonal turning. |
| 3 | Estimation of Power required during orthogonal turning. |
| 4 | Torque and Thrust measurement during drilling. |
| 5 | Forces measurement during plain milling operation. |
| 6 | Measurement of Chip tool Interface temperature during turning using thermocouple technique. |
| 7 | Exercise involving cylindrical grinding on surface grinding machine. |
| 8 | Study the variation of surface roughness with different speed and feed during plain milling operation on flat surface. |
| 9 | Study of capstan lathe and its tooling and prepare a tool layout & job as per given drawing. |
| 10 | Engrave a profile on given workpiece using EDM machine. |
| 11 | Exercises for boring of cylindrical bores and machining of external surfaces coincident with internal bores on boring machine. |

**Course outcome**

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

**CO1:** Measurement of chip reduction coefficient , various forces on tool and power during orthogonal turning

**CO2:** analyze thrust and torque during drilling

**CO3:** evaluate chip tool interface temperature during turning using thermocouple technique

**CO4:** study of variation of surface roughness with different speed and feed during plain milling operation on flat surface

**CO5:** making a job on capstan lathe , grinding machine , boring and EDM machine

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 | PSO1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 1 | 2 | 1 | | | | | | | | |
| **CO2** | 3 | 3 | 2 | 2 | 1 | | | | | | | | |
| **CO3** | 3 | 3 | 2 | 2 | 1 | | | | | | | | |
| **CO4** | 3 | 3 | 1 | | | | | | | | | | |
| **CO5** | 3 | | 2 | 2 | 1 | | | | | | | | |
| | | **Average** | **3.0** | **3.0** | **1.6** | **2.0** | **1.0** | | | | | | |

# PIP311: OPERATIONS RESEARCH LAB.

**B.Tech. (P&I) 6th Semester**

**0L+0T+2P** **Exam Hours: 2**

| SN | LABORATORY WORK/NAME OF EXPERIMENT |
|---|---|
| | **Solve using software and verify with analytical methods** |
| **1** | Linear programming problem |
| **2** | Assignment problem |
| **3** | Transportation problem |
| **4** | Integer programming problem |
| **5** | Queuing Problem |
| **6** | Inventory problem |
| **7** | Simulation Problem |
| **8** | Replacement Problem |
| **9** | Decision Tree |
| **10** | Game theory |

**Course outcome**

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

**CO1:** Examine long term decision of location , layout and capacity planning.

**CO2:** Construct process control chart.

**CO3:** Develop work methods and improve productivity

**CO4:** Model various inventory management system

**CO5:** Construct project management of real life problem

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 PSO1 PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 3 | 3 | 1 | | | | 1 | | | 1 |
| **CO2** | 3 | 2 | 2 | 3 | 1 | | | | | | | |
| **CO3** | 3 | 2 | 2 | 3 | 1 | | | | 2 | | | 1 |
| **CO4** | 3 | 2 | 3 | 3 | 2 | | | | 1 | | | 2 |
| **CO5** | 3 | 3 | 3 | 3 | 1 | 2 | 2 | | 1 | | | 1 |
| **Average** | **3.0** | **2.4** | **2.6** | **3.0** | **1.2** | **2.0** | **2.0** | | **1.3** | | | **1.3** |

## PIP313: STATISTICAL LAB.

**B.Tech. (P&I) 6th Semester**

| SN | LABORATORY WORK/NAME OF EXPERIMENT |
|---|---|
| | **Solve using software and verify with analytical methods** |
| 1 | **Hypothesis Testing**<br>• Mean: One Sample z test, Two sample z test, One Sample t test, Two Sample t test, Paired t-test, Poisson test with Bonferroni, Dunn-Sidak adjustments<br>• Variance: Single Variance, Equality of Two Variances, Equality of Several Variances |
| | • Correlation: Zero Correlation, Specific Correlation, Equality of Two Correlations<br>• Proportion: Single Proportion, Equality of Two Proportions<br>• Appropriate Quick Graphs<br>• Resampling Bootstrap, without replacement, Jackknife |
| 2 | **Descriptive Statistics**<br>• Coefficient of variation, std err of mean<br>• Adjustable confidence intervals of mean<br>• Skewness, kurtosis, including standard errors |
| 3 | **Design of Experiments**<br>• Complete and incomplete factorial designs<br>• Latin square designs, 3-12 levels per factor<br>• Box and Hunter 2-level incomplete designs<br>• Taguchi designs |
| 4 | **ANOVA**<br>• Designs: unbalanced, randomized block, complete block, fractional factorial, mixed model, nested, split plot, Latin square, crossover and change over,<br>• ANCOVA<br>• Means model for missing cells designs<br>• Repeated measures: one-way, two or more factors, three or more factors<br>• Options to test normality and homoscedasticity assumptions<br>• Type I , II and III sums of squares |
| 5 | **Time Series**<br>• Smoothing: LOWESS, moving average, running median, and exponential<br>• Seasonal adjustment<br>• Fourier and inverse Fourier transforms<br>• Box-Jenkins ARIMA model<br>• Specify autoregressive, difference and moving average parameters<br>• Forecast and standard errors |

# PIL214: MANAGEMENT INFORMATION SYSTEM

**B.Tech. (P&I) 7th semester**
**4L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | Organisation & Types, Decision Making, Data & information, Characteristics & Classification of information, | 3 |
| | Cost & value of information, Various channels of information & MIS. | 2 |
| II | Foundation of Information System : Introduction to Information System in Business Fundamentals of Information System, Solving Business Problems with Information System, | 4 |
| | Concept of Balanced MIS, Effectiveness & Efficiency Criteria. Tool and Techniques of MIS- dataflow diagram, flow chart etc. | 4 |
| III | Business application of information technology, electronic commerce, Internet, Intranet, Extranet & Enterprise Solutions, Information System for Business Operations, | 5 |
| | Information system for managerial Decision Support, Information System for Strategic Advantage | 5 |
| IV | Managing Information Technology, Enterprise & Global Management, Security & Ethical Challenges, Planning & Implementing Change.. | 4 |
| | Reports: Various types of MIS reports, GUI & Other Presentation tools | 4 |
| V | Advanced concepts in information system: Enterprise Resource Planning: introduction, various modules like Human Resources, Finance, Accounting, Production & Logistics. | 5 |
| | Supply Chain Management, CRM, Procurement Management System Object Oriented modeling case studies. | 4 |
| | **TOTAL** | **40** |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Information systems for Modern Management, G.R.Murdick, Prentice Hall of India | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| **1** | Management Information systems, S.Sadagopan, Prentice Hall of India | |
| **2** | Management Information Systems, Effy Oz, Cengage Learning | |
| **3** | Management Information Systems, James A O Brien, Irwin McGraw Hill | |
| **4** | Management Information Systems, Laudon and Laudon, Prentice Hall of India | |

# PIL316: METAL FORMING PROCESSES

**B.Tech. (P&I) 7th semester**

**3L+0T**

| Unit | Contents | Contact hours |
|---|---|---|
| I | **FUNDAMENTALS OF METAL FORMING** Classification of forming processes, Mechanics of metal working, Flow stress determination, Temperature in metal working, strain rate effects, metallurgical structures, deformation zone theory, hydrostatic pressure, residual stresses, Spring back | 6 |
| | Review of state of stress – Components of stress, behavior of metal when subjected to stress, Introduction to stress tensor, principal stresses, Stress deviator, Mohr's circle of stress (two dimension and three dimensions), Mohr's circle of strain, von-mises, Tresca yield criteria. | 4 |
| II | **FORGING:** Classification, equipment, forging in plain strain, open-die forging, closed-die forging, calculation of forging loads in closed-die forging, forging defects, powder metallurgy forging, residual stresses in forging. | 4 |
| | **ROLLING:** Classification, Rolling mills, hot and cold rolling, rolling of bars and shapes, forces and geometrical relationships, simplified analysis of rolling load: rolling variables, Problems and defects in rolled products, theories of cold and hot rolling, torque and power. | 6 |
| III | **EXTRUSION:** Classification of extrusion processes, equipment, hot extrusion, deformation, lubrication and defects in extrusion, analysis of the extrusion process, cold extrusion and cold forming, hydrostatic extrusion, extrusion of tubing, influence of friction, extrusion force calculation, production of seamless pipe and tubing. | 6 |
| | **DRAWING OF RODS, WIRES AND TUBES;** Introduction, rod and wiredrawing, analysis of wiredrawing, tube-drawing processes, analysis of tube drawing, residual stresses in road, wire, and tubes, defects, Tube drawing and sinking processes, Tube bending, Limiting Draw ratio - processes: Deep drawing, | 8 |
| IV | Explosion forming, electro hydraulic forming, Magnetic pulse forming. | 4 |
| | **TOTAL** | 38 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | Rao, P.N. "Manufacturing Technology", Vol 2, 3 TMH Ltd., | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | Nagpal G.R. "Metal forming processes", Khanna publishers. | |
| 2 | Serope Kalpakjian, Steven R Schmid, "Manufacturing Process for Engineering Materials" – Pearson Education | |
| 3 | Edward M. Mielink, "Metal working science Engineering, McGraw Hill, Inc,. | |
| 4 | Metal Hand book Vol.14, "Forming and Forging", Metal Park, Ohio, USA. | |
| 5 | Dieter G.E., "Mechanical Metallurgy", McGraw Hill, Co., S.I. | |

**Course outcome**

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

**CO1:** Distinguish between different metal forming process

**CO2:** Analyse the parameters involved in Forging ,Rolling, Extrusion and wire drawing

**CO3:** Evaluate the force estimation for bulk and sheet metal operations

**CO4:** compare and judge the appropriate forming operation for specific work

**CO5:** Recognise the Advanced metal forming process such as , Laser forming , micro forming, super plastic forming etc

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 2 | 1 | 2 | | | | | | | | | |
| **CO2** | 3 | 3 | 2 | 1 | 2 | | | | | | | | | |
| **CO3** | 2 | 3 | 2 | 2 | | | | | | | | | | |
| **CO4** | 3 | 3 | 2 | 2 | | | | | | | | | | |
| **CO5** | 3 | 3 | 2 | 2 | 3 | | | | | | | | | |
| | | Average | | 2.8 | 2.8 | 2.0 | 1.6 | 2.3 | | | | | | |

# PIL318 : COMPUTER INTEGRATED MANUFACTURING

**B.Tech. (P&I) 7th semester**

**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Introduction to CIM:**Overview of Production Systems, the product cycle, Automation in Production Systems, computer's role in manufacturing, sources and types of data used in manufacturing. The Beginning ofCAM: Historical Background, | 2 |
| | Introduction to manufacturing System, Classification of manufacturing system, overview of classification scheme, manufacturing progress functions. | 3 |
| II | Computer Aided Process Planning (CAPP): Traditional Process Planning,Retrieval process planningsystem, Generative Process Planning, Machinability data systems, computer generated timestandards. | 8 |
| III | Group Technology (GT): Introduction, part families, part classification and coding, codingsystem and machining cells. Introduction to Product data Management System (PDM) | 4 |
| | Computer Aided Production Management Systems (CAPM): Introduction to computer aided PPC, Introduction tocomputer aided inventory management, manufacturing resource planning (MRPII), computer processmonitoring and shop floor control, and computer process control. | 5 |
| IV | Computer Aided Quality Control (CAQ); Computer in quality control, Off-Line and On-Line Quality control, Automated inspection, contact inspection methods, Non contact inspection methods: optical and non opticalcomputer aided testing. Overview of automatic identification methods. | 5 |
| | Flexible manufacturing systems (FMS). Types of FMS, Flexibility in manufacturing, FMS components, FMS applications and benefits. | 4 |
| V | Product Design and CAD/CAM in the production system: Introductory concepts Product design and CAD, CAM,CAD/CAM and CIM | 4 |
| | Collaborative Engineering; Introduction, Faster Designthroughput, Web based design, Changing design approaches, extended enterprises, concurrentengineering, Agile and lean manufacturing. | 5 |
| | **TOTAL** | **40** |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Mikell P. Groover, , Automation, Production Systems, and Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall, | 2008 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| **1** | James A. Rehg and Henry W. Kraebber, Computer-Integrated Manufacturing, 3rd ed., Pearson/Prentice Hall, | 2005 |
| **2** | Nanua Singh, Systems Approach to Computer-Integrated Design and Manufacturing, John Willey & Sons. | 1996 |
| **3** | Computer Aided Manufacturing, Chang, Wysk and Wang, Pearson Education | 2008 |
| **4** | CAD/CAM: Principles and Applications, P.N. Rao, McGraw Hill | 2003 |
| **5** | Computer Control of Manufacturing Systems,Y. Koren, McGraw Hill | 2009 |
| **6** | Computer aided Manufacturing, Rao, Tiwari and Kundra, Tata McGraw Hill. | 2002 |
| **7** | Computer Numerical Control: Machining and Turning Centres, Quesada and Jeyepoovan, PearsonEducation | 2007 |

**Course outcome**

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

**CO1:** Describe the elements of the CIMS

**CO2:** Explain computer aided process planning

**CO3:** Discuss and solve the problem in part coding system in GT and PDM

**CO4:** Explain computerised quality control

**CO5:** Construct the product design, CAD/CAM in production system and collaborative engineering

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO1 | PO1 | PO1 PSO1 PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | 1 | | 3 | | | | | | | |
| **CO2** | 3 | 3 | 2 | | 3 | | | | | | | |
| **CO3** | 3 | 3 | 3 | | 3 | | | | | | | |
| **CO4** | 3 | 3 | 3 | | 3 | | | | | | | |
| **CO5** | 3 | 3 | 3 | 1 | 3 | 1 | | | | | | |
| **Average** | **3.0** | **2.8** | **2.4** | **1.0** | **3.0** | **1.0** | | | | | | |

## PIL322: FINITE ELEMENT METHODS

**B.Tech. (Mechanical) 7th semester** **Max. Marks: 150**

**4L+0T** **Exam Hours: 3**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | Introduction to FEM, Applications and Advantages of FEM, Gauss elimination method, Uniqueness of solution, Banded symmetric matrix and bandwidth. | 4 |
| | Direct stiffness method: Two-force member element, Local stiffness matrix, Assembly, Global stiffness matrix, imposition of Boundary conditions, Properties of stiffness matrix | 5 |
| II | One-dimensional Finite Element Analysis: Basics of structural mechanics, stress and strain tensor, constitutive relation, Principle of minimum Potential Energy, General steps of FEM, Discretization, Derivation of finite elements equations using potential energy approach for linear and quadratic 1-D bar element. | 5 |
| | Shape functions and their properties, Assembly, Boundary conditions, Computation of stress and strain. | 5 |
| III | Two Dimensional Finite Element Analysis: Finite element formulation using three nodded triangular (CST) element, Plane stress, Plane strain and Axisymmetric problems. | 4 |
| | Shape functions, node numbering and connectivity, Assembly, Boundary conditions, Isoparametric formulation of 1-D bar elements and 4 noded quadrilateral elements. | 4 |
| | Numerical integration using gauss quadrature formula, computation of stress and strain. | 3 |
| IV | Finite Element Formulation from Governing Differential Equation: Method of Weighted Residuals-Galerkin method. | 4 |
| | Application to one dimensional heat conduction problems and fluid flow. Introduction to variational formulation (Ritz Method.) | 6 |
| V | Shape functions for higher Order Elements: Family of triangular and quadrilateral elements, compatibility, Lagrangian and Serendipity element, element continuity, Convergence of solution:p and h methods of refinement, Aspect ratio and element shape, | 8 |
| | Structural Dynamics: Concept of element mass matrix, Natural frequencies of one-dimensional bar. | 2 |
| | **TOTAL** | **50** |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | SeshuP.,"Text Book of Finite Element Analysis", Prentice Hall India | **2003** |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |

| | | |
|---|---|---|
| **1** | Dixit, U. S., "Finite Element Methods for Engineers" Cengage Learning | **2003** |
| **2** | Finite Element Procedure in Engineering Analysis, Bathe K.J., Prentice Hall India. | **2001** |
| **3** | An Introduction to the Finite Element Method, Reddy J.N., Tata McGraw-Hill, New Delhi | **1993** |
| **4** | Concepts & Applications of Finite Element Analysis, Cook and Plesha, Willey India New Delhi. | **2007** |
| **5** | Introduction to Finite Elements in Engineering, Chandupatla and Belegundu, Prentice Hall India. | **1999** |


| **Course outcome** |
|---|
| **At the end of the course, the student will be able to** |
| **CO1:**Apply direct stiffness method for structural analysis and explain the concept of global stiffness matrix and boundary conditions. |
| **CO2:**Formulate and solve one dimensional structural problem using linear and quadratic elements and explain concept of shape function & its properties. |
| **CO3:**Formulate and solve plane stress and plane strain problems using CST elements |
| **CO4:**Formulate and solve one dimensional heat transfer problems |
| **CO5:**Develop shape functions for higher order elements and explain the concept of convergence & refinement |

**CO-PO Mapping**

| **Course Outcomes** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 2 | 1 | | | | | | | |
| **CO2** | 3 | 3 | 2 | 2 | 2 | | | | | | | 3 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | | | | | | | 3 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | | | | | | | 3 |
| **CO5** | 3 | 2 | 2 | 1 | 2 | | | | | | | |
| **Average** | **3.0** | **2.8** | **2.0** | **1.8** | **1.8** | | | | | | | **3.0** |

## PIL413: PLASTIC TECHNOLOGY

**B.Tech. (P&I) 7th semester**
**4L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| **I** | Design of polymeric product. Design criteria based upon product functions and geometry. Material selection by property assessment. Selection of appropriate forming processes. | **8** |
| **II** | Injection mould design: Single, multicavity, semi automatic and automatic moulds. Types of injection mould, their application, detailed structure and working. Feed system, Temperature control system, Ejection System, Standard Mould base | **6** |
| **III** | Split Mould and types of mechanism, Unscrewing mechanism, Introduction to Hot runner mould. | **6** |
| **IV** | **Machining of Plastics**: Drilling and Reaming, Thread Tapping, Sawing, Milling, Turning, Grinding and Routing | **8** |
| **V** | **Finishing and Decorating of Plastics**: Painting, Vacuum Metallizing and Sputter Plating, Electroplating, Flame Spraying/Arc Spraying, Hot Stamping | **8** |
| | **TOTAL** | **36** |

## PIP314: METAL FORMING AND TOOL DESIGN SESSIONAL

**B.Tech. (P&I) 7th Semester**
**0L+0T+3P**

| SN | SESSIONAL WORK |
|---|---|
| **1** | Functional requirements of machine tools. |
| **2** | Working and auxiliary motions in machine tools. |
| **3** | Design criterion for machine tool structure, Static & dynamic stiffness. |
| **4** | Function & important requirements of spindle unit. |
| **5** | Importance of machine tool compliance with respect to machine tool accuracy. |
| **6** | Application and sketching of Slider-crank mechanism, Cam mechanism, Rack & pinion mechanism, Nut & screw mechanism, Ratchet gear mechanism, Geneva mechanism, Reversing mechanism, Differential mechanism, Norton mechanism, Mender's mechanism. |
| **7** | Aim of speed & feed rate regulation, stepped regulation of speed. |
| **8** | G.P. series is used in steeped regulation of speed. |
| **9** | Design a four / six speed Gear Box. |
| **10** | Design of Lathe bed. (including Torque analysis of lathe bed, bending of lathe bed, designing for torsional rigidity, use of reinforcing stiffener in lathe bed) |
| **11** | Analysis of force under headstock, tail stock and saddle. |
| **12** | Design of Guide ways / Slide ways. |
| **13** | Estimation of power requirements and selection of motor for metal cutting machine tool spindles. |

## PIP315: CIMS Lab(CAM, IE & SIMULATION Practicals )

**B.Tech. (P&I) 7th Semester**
**0L+0T+3P**

| SN | NAME OF EXPERIMENT |
|---|---|
| 1 | To prepare part programming for plain turning operation. |
| 2 | To prepare part program for turning operations using turning cycle. |
| 3 | To prepare part program for threading operation. |
| 4 | Toprepare part program for gear cutting using mill cycle. |
| 5 | To prepare part program for multiple drilling in X and Z axis using drilling cycle. |
| | Case Study on the following: |
| 1 | Work Methods Design |
| 2 | Process Control Charts |
| 3 | Materials Management |
| 4 | Capacity Planning |
| | **Simulation experiments** |
| 1 | Generate Pseudo Random No. using different Techniques |
| 2 | Develop an Analytical Model for a given physical system |
| 3 | Develop a Monte-Carlo Simulation Model for a given physical system |
| 4 | Find a area of an irregular 2-D shape using Monte-Carlo Simulation |
| 5 | Find the effectiveness of simulation on a physical Stochastic System |
| 6 | Develop an algorithm for a selected Simulated Study and write the program in a high level language. |
| 7 | Modeling of manufacturing system using simulation software such as ARENA |

# PIL319: OPTIMIZATION TECHNIQUES

**B.Tech. (P&I) 7th semester**
**4L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Introduction**- Engineering Applications of Optimization-Statement of an Optimization Problem-Classification of Optimization Problems-Optimization Techniques | 5 |
| II | **Classical Optimization Techniques**-Single-Variable Optimization-Multi variable Optimization with No Constraints-Multivariable Optimization with Equality Constraints- Multivariable Optimization with Inequality Constraints- Transportation | 4 |
| III | **Nonlinear Programming I**: 1DMinimization Methods-Unimodal Function, Elimination Methods-Unrestricted Search, Exhaustive, Dichotomous Search- Interval Halving Method- Fibonacci Method-Golden Section Method, Interpolation Methods-Quadratic, Cubic Interpolation Method - Direct Root Methods-Newton Method-Quasi-Newton, Secant Method | 7 |
| IV | **Nonlinear Programming II**: Unconstrained Optimization Techniques-Direct Search Methods- Indirect Search (Descent) Methods, Non-linear Programming III: Constrained Optimization Techniques- Direct Methods-Indirect Methods, Geometric Programming, Dynamic Programming, Integer Programming –Integer Linear Programming - Stochastic Programming. | 4 |
| V | **Modern Methods of Optimization**- Genetic Algorithms-Simulated Annealing-Particle Swarm Optimization- AntColony Optimization-Optimization of Fuzzy Systems- Neural- Network- Based Optimization, Practical Aspects of Optimization | 4 |
| | **TOTAL** | **40** |

| **TEXT BOOK** | | |
|---|---|---|
| **1** | Kalyanmoy Deb, "Optimization for Engineering design –algorithms & examples", PHI, New Delhi | 1995 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| **1** | Singiresu S.Rao, "Engineering optimization– Theory and practices", John Wiley and Sons, | 1998. |
| **2** | Garfinkel, R.S. and Nemhauser, G.L., "Integer programming", John Wiley & Sons, | 1972. |

CO1: **Describe** the basic concepts of engineering optimization.
CO2: **Solve** the problems using different techniques of optimization.
CO3: **Understand and implement** the modern methods of optimizations.

| Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 2 | 2 | - | 1 | - | - | - | - | - | - | - | - |
| C02 | 3 | 3 | 2 | 2 | 1 | - | - | - | - | - | - | - |
| C03 | 3 | 3 | 2 | 1 | 3 | - | - | - | - | - | - | - |

## PIL411:INTERNET OF THINGS AND MACHINE LEARNING

**B.Tech. (P&I) 7th semester** **4L+0T**

**Course Learning Objectives:**

1. Impart necessary and practical knowledge of components of Internet of Things
2. Develop skills required to build real-life IoT based projects.
3. Introduce to the basic concepts and techniques of Machine Learning.
4. Develop skills of using recent machine learning software for solving practical problems.

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| | **Introduction to IoT and Machine Learning** | **1** |
| **I** | **IoT:** What is IoT, how does it work? Difference between Embedded device and IoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market<br><br>**Setting Up Raspberry/Arduino to Create Solutions:** Explore Raspberry Pi, Setting up Raspberry Pi, Showing working of Raspberry Pi using SSH Client and Team Viewer, Understand Sensing actions, Understand Actuators and MEMS | 5 |
| **II** | **Communication Protocols used in IoT:** Types of wireless communication, Major wireless Short- range communication devices, properties, comparison of these devices ( Bluetooth, WIFI, ZigBee, 6LoWPAN) Major wireless Long-range communication devices, properties, comparison of these devices ( Cellular IoT, LPWAN)<br><br>**IoT Applications:** Industrial Internet 4.0, Applications such as: Smart home, wearables, smart city, smart grid, connected car, connected health(digital health, telehealth, telemedicine), smart retail | 6 |
| **III** | **Sensors:** Applications of various sensors: Google Maps, Waze, Whats App, Ola Positioning sensors: encoders and accelerometers, Image sensors: cameras, Global positioning sensors: GPS, GLONASS, IRNSS, Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer, Magnetometer, Proximity Sensor, Gyroscope Calibration, noise modeling and characterization and-noise | 4 |

| | | |
|---|---|---|
| | filtering and sensor data processing. Privacy & Security | |
| **IV** | **Basics of Machine Learning:**Applications of Machine Learning, processes involved in Machine Learning, Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, Real life examples of Machine Learning. | 6 |
| **V** | **Supervised Learning:**Classification and Regression: K-Nearest Neighbour, Linear Regression, Logistic Regression, Support Vector Machine (SVM), Evaluation Measures: SSE, MME, R2,confusionmatrix,precision,recall,F- Score, ROC-Curve.<br><br>**Unsupervised Learning:** Introduction to clustering, Types of Clustering: Hierarchical- Agglomerative Clustering and Divisive clustering; Partitioned Clustering- K-means clustering, Principal Component Analysis, ICA. | 6 |

**Text Books:**


1 CunoPfister, Getting Started with the Internet of Things, OReillyMedia 2011
2 Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing 2015
3 Tom Mitchell, Machine Learning, McGraw Hill, 2017


**Reference Books:**


4 Vijay Madisetti and Arshdeep Bahga, Internet of Things (AHands-on Approach), 1st Edition, VPT 2014
5 Francis daCosta, Rethinking the Internet of Things: A ScalableApproach to Connecting Everything, 1stEdition, Apress Publications 2013
6 Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2011
7 T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2 editions, 2008


**MOOCs on this course are available at:**

1 Introductionto Internetof Things- https://www.edx.org/course/introduction-to-the-internet-of-things-iot
2 IoTProgrammingandBigData-https://www.edx.org/course/iot-programming-big-data-curtinx-iot4x
3 Data Science: Machine Learning - https://www.edx.org/course/data-science-machine-learning

4 MachineLearning- https://www.coursera.org/learn/machine-learning

**Course Outcomes:**

Students will be able to

1. Understand internet of Things and its hardware and software components Interface I/O devices, sensors & communication modules
2. Remotely monitor data and control devices
3. Develop real life IoT based projects
4. Recognize the characteristics of machine learning that make it useful to real-world problems.
5. Understand the basic underlying concepts for supervised, semi-supervised, and unsupervised learning.
6. Effectively use machine learning toolboxes.

## PIL421: COMPOSITE MATERIALS TECHNOLOGIES

**B.Tech. (P&I) 7th semester** **4L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Introduction of Composites:** Definition, Classification, Metal matrix, Polymer matrix and Ceramic matrix composites, Types of fibres and matrix materials and their properties, Lamina and Laminate:Particulate Composites. | 5 |
| | **Advantages and applications:** Advantages and applications of composites in present world | 3 |
| II | **Manufacturing and Fabrication of Composites:** Hand lay-up technique; Autoclave moulding; Pressure bag and vacuum bag moulding; Pultrusion; Resin-transfer moulding; Injection moulding; Prepregs | 4 |
| | **Elastic Behaviour of Composite Lamina-Micromechanics:** Volume fraction, weight fraction, density of composites; Longitudinal elastic properties, transverse elastic properties, in-plane shear modulus, Poisson's ratio, Halpin-Tsai equations | 5 |
| III | **Elastic behaviour of unidirectional Lamina:** Stress-Strain relationsfor a thin lamina, general anisotropic materials, orthotropic material, transversely isotropic material, isotropic material. | 8 |
| IV | **Introduction to multi-directional Laminates:** Laminate orientation code, symmetric and balanced laminate; cross-ply, angle-ply and quasi isotropic laminates; | 3 |
| | **Special Types of Composites:** Short fibre composites; Sandwich structure composites; Honeycomb structure composites. | 4 |
| V | **Mechanical Testing of Composites:** Tensile testing; Compressive testing; Intra-laminar shear testing; Fracture testing; Fatigue testing | 4 |
| | **Failure and Maintenance of Composites:** Introduction to failure modes in laminates; Damage to laminate structures; Inspection Methodology, Quality control, case studies | 4 |
| | **Total** | 40 |

TEXT BOOKS:-

1. "Analysis and Performance of Fiber Composites", B. D. Agarwal & L. J. Broutman, John Wiley & Sons

2. "Engineering Mechanics of Composite Materials", I.M. Daniel & O. Ishaai, Oxford University Press

REFERENCE BOOKS:-

1. “Mechanics and Analysis of Composite Materials”, V.V. Vasiliev& E.V. Morozov, Elsevier Science Ltd.

2. “Mechanics of Composite Materials”, R.M. Jones, Technomic Publication

3. “Composite Material: Science and Engineering”, Krishnan K. Chawle. Springer

4. “An Introduction to metal matrix composites”, T. W. Clyne& P.J. Withers, Cambridge University Press

| **Course outcome** |
|---|
| **At the end of the course, the student will be able to** |
| **CO1:**Identify the role of matrices and reinforcements used in practical composite structures. |
| **CO2:** Develop understanding of different methods of manufacturing and micro-mechanical model to estimate the lamina properties |
| **CO3:**Ability to analyze problems on macro mechanical behavior of composites |
| **CO4:** Understand application of laminate to different composite structures |
| **CO5:** Perform characterization of composites and study of composite failure and its maintenance. |

**CO-PO Mapping**

| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 2 | 2 | 2 | 2 | | | | | | | | |
| **CO2** | 2 | 3 | 2 | 2 | | | | | | | | 3 |
| **CO3** | 2 | 3 | 2 | 2 | | | | | | | | 3 |
| **CO4** | 2 | 2 | 2 | 2 | | | | | | | | 3 |
| **CO5** | 2 | 3 | 2 | 2 | | | | | | | | |
| **Average** | **2.0** | **2.6** | **2.0** | **2.0** | | | | | | | | **3.0** |

# PIL430: RENEWABLE ENERGY SYSTEMS

**B.Tech. (P&I) 7th semester**
**4L+0T**

| Unit | CONTENTS | Contact Hours |
|---|---|---|
| I | Global and National scenarios, Form and characteristics of renewable energy sources.<br>**Solar Energy:** Solar radiation, its measurements and prediction, Solar thermal collectors, flat plate collectors, concentrating collectors, Basic theory of flat plate collectors, solar heating of buildings, solar still, solar water heaters, solar driers, conversion of heat energy in to mechanical energy, solar thermal power generation systems. | **2** |
| | **Solar Photovoltaic:** Principle of photovoltaic conversion of solar energy, types of solar cells and fabrication, **Photovoltaic applications:** battery charger, domestic lighting, street lighting, water pumping, power generation schemes | **3** |
| II | **Wind Energy:** Atmospheric circulations, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS- classification, characteristics, applications. | **3** |
| III | **Ocean Energy:** Ocean energy resources, ocean energy routes, Principles of ocean thermal energy conversion systems, ocean thermal power plants, Principles of ocean wave energy conversion and tidal energy conversion. | **4** |
| IV | **Other Sources:** Nuclear fission and fusion, Geothermal energy- Origin, types of geothermal energy sites, site selection, geothermal power plants, Magneto-hydro-dynamic (MHD) energy conversion, Formation of biomass, photosynthesis, Biomass resources and their classification, Chemical constituents and physicochemical characteristics of biomass, Biomass conversion processes. | **5** |
| V | **Fuel Cells:** Thermodynamics and electrochemical principles, Basic design, types, applications.<br>**Hydrogen Energy:** Economics of hydrogen, Production methods. | **5** |
| | **TOTAL** | **40** |

| **TEXT BOOK** | | **Ed.** |
|---|---|---|
| **1** | Power Generation through Renewable Source of Energy, Rai and Ram Prasad, Tata McGraw-Hill, New Delhi. | 2004 |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Pub Year .** |
| **2** | Renewable Energy Sources and Conversion Technology, Bansal, Kleemann and Meliss, TMH | 2013 |
| **3** | Solar Energy: Fundamental and Applications, H. P. Garg J Prakash, TataMcGraw-Hill | 2006 |
| **4** | Solar Energy: Principles of Thermal Collection and Storage, S P Sukhatme, TMH | 1994 |

| | |
|---|---|
| **CO 1** | To understand the various renewable systems |
| **CO 2** | To learn the various sources of renewable energy |
| **CO 3** | To examine the operating conditions of systems |
| **CO 4** | To explore the systems and apply for various purposes |

| Course Outcomes | P01 | P02 | P03 | P04 | P05 | P06 | P07 | P08 | P09 | P10 | P11 | P12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C01 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - |
| C02 | 3 | 2 | 1 | 2 | - | - | - | - | - | - | - | - |
| C03 | 3 | 3 | 2 | 1 | - | - | - | - | - | - | - | - |
| C04 | 3 | 3 | 1 | 2 | - | - | - | - | - | - | - | - |
| CO5 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | - | - |

# PIL410 : MODELING AND SIMULATION

**B.Tech. (P&I) 8th semester**
**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Physical modeling :** Concept of system and environment, continuous and discrete system, linear and nonlinear system, stochastic activities, static and dynamic models, principles used in modeling, Basic simulation modeling, | 4 |
| | Role of simulation in model evaluation and studies, Advantages and Disadvantages of simulation. Modeling of Systems, iconic analog. Mathematical Modeling | 4 |
| II | **Computer system simulation:** Technique of simulation, Monte Carlo method, experimental nature of simulation, numerical computation techniques, continuous system models, analog and hybrid simulation, feedback systems, | 4 |
| | Buildings simulation models of waiting line system, Job shop, material handling and flexible manufacturing systems | 4 |
| III | **Probability concepts in simulation:** Stochastic variables, discrete and continuous probability functions, random numbers, generation of random numbers, | 4 |
| | Variance reduction techniques, Determination of the length of simulation runs, Output analysis. | 4 |
| IV | **System dynamics modelling:** Identification of problem situation, preparation of causal loop diagrams and flow diagrams, equation writing, level and rate relationship. | 5 |
| | Simulation of system dynamics model. | 3 |
| V | **Verification and validation:** Design of simulation experiments, validation of experimental models, testing and analysis. | 4 |
| | Simulation languages comparison and selection, study of SIMULA, DYNAMO, STELLA, POWERSIM. Simulation softwares. | 4 |
| | **TOTAL** | **40** |

**TEXT BOOK**

| | |
|---|---|
| 1 | Simulation Modeling and Analysis, Law A.M., McGraw Hill. |

**REFERENCE BOOKS**

| SN | Name of Authors /Books /Publisher | Year of Pub. |
|---|---|---|
| 1 | Discrete-Event System Simulation, Banks and Carsan, Prentice Hall of India | |
| 2 | Simulation Modeling and Analysis with ARENA, Altiok and Melamed, Academic Press | |
| 3 | Simulation with ARENA, Keltan, Sadowski and Turrock, McGraw Hill | |
| 4 | Simulation Modeling and ARENA, Rossetti and Taha, John Wiley and Sons | |
| 5 | Dynamic Systems: Modeling, Analysis and simulation, Finn Hangen, Tapir Academic Press | |

# PIL420: PRODUCT DEVELOPMENT AND LAUNCHING

**B.Tech. (P&I) 8th semester**

**3L+0T**

| UNIT | CONTENTS | CONTACT HOURS |
|---|---|---|
| I | **Importance of New Product:** Definition-importance- Development Process, Importance of new product for growth of enterprise, Definition of product and new product | 2 |
| | Responsibility for new product development, Demands on product development team, Classification of products from new product development point of view- Need based/Market pull products, Tech. push, Platform based, Process based and customized products | 3 |
| | New product development process and organization, Generic product development process for Market Pull Products, Modification of this process for other types of products. | 3 |
| II | **Need Analysis:** Problem Formulation Establishing economic existence of need, Need Identification and Analysis, Engineering Statement of Problem, Establishing Target Specification. | 8 |
| III | **Generation of Alternatives and Concept Selection:** Concept generation- a creative process, Creativity, Road Elects to creative thinking-Fear of criticism and Psychological set**.** | 4 |
| | Tools of creativity like brain storming, Analogy, Inversion etc., Creative thinking Process, Concept feasibility and Concept Selection, Establishing Engineering Specification of Products. | 4 |
| IV | **Preliminary and Detailed Design:** Design Review Preliminarydesign-Identification of subsystems, Subsystemspecifications, Compatibility, Detailed design of subsystems, component design, | 6 |
| | Preparation of assembly drawings, Review of product designfrom point of view of Manufacturing, Ergonomics and aesthetics. | 2 |
| V | **Management of New Product:** Development and Launch NewProduct Management's Challenges, Maintaining focus, Promotion of Right Culture, Management of Creativity, Top Management attention, Design Team Staffing and Organization, Setting key mile stone, Identification of Risk Areas, Project Execution and Evaluation Product Launch Strategies, | 8 |
| | **TOTAL** | 40 |

| **TEXT BOOK** | | |
|---|---|---|
| 1 | Product Design and Manufacturing, Chitale and Gupta. McGraw Hill. | |
| **REFERENCE BOOKS** | | |
| **SN** | **Name of Authors /Books /Publisher** | **Year of Pub.** |
| 1 | Product Design and Development, Ulrich and Eppinger, McGraw Hill | 2003 |
| 2 | Project Management in New Product Development, Barkley B.T., Tata McGraw Hill. | 2008 |
| 3 | Product Management, Anandan C., McGraw Hill. | 2009 |
| 4 | Engineering Design Methods, Cross, Nigel, John Wiley and Sons. | 1995 |
| 5 | Product Design and Manufacture, Lindbeck, J.R., Prentice Hall of India. | 1995 |