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| **KERALA TECHNOLOGICAL UNIVERSITY**  http://ktu.edu.in/images/logo_final.png  **SCHEME AND SYLLABUS**  **FOR**  **M. Tech. DEGREE PROGRAMME**  **IN**  **MECHANICAL ENGINEERING**  **WITH SPECIALIZATION**  **PRODUCTION AND INDUSTRIAL ENGINEERING**  **CLUSTER 05 (ERNAKULAM II)**  **KERALA TECHNOLOGICAL UNIVERSITY CET Campus, Thiruvananthapuram Kerala, India -695016**  **(2015 ADMISSION ONWARDS)** |

**KERALA TECHNOLOGICAL UNIVERSITY**

**SCHEME AND SYLLABUS FOR M. Tech. DEGREE PROGRAMME**

**Branch: MECHANICAL ENGINEERING**

**Specialization: Production and Industrial Engineering**

**Semester 1** (Credits: 21)

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| Exam Slot | Course No: | Name | L- T - P | Internal  Marks | End Semester Exam | | Credits |
| Marks | Duration (hrs) |
| A | 05ME 6001 | Advanced Engineering Materials and Processing | 3-1-0 | 40 | 60 | 3 | 4 |
| B | 05ME 6003 | Manufacturing Systems Management | 3-1-0 | 40 | 60 | 3 | 4 |
| C | 05ME 6005 | Computer Aided Design in Manufacturing | 3-1-0 | 40 | 60 | 3 | 4 |
| D | 05ME 6007 | Quality Engineering and Management | 3-0-0 | 40 | 60 | 3 | 3 |
| E | 05ME 601x | Elective-I | 3-0-0 | 40 | 60 | 3 | 3 |
|  | 05ME 6077 | Research Methodology | 0-2-0 | 100 | 0 | 0 | 2 |
|  | 05ME 6091 | Manufacturing and Precision Engineering Laboratory | 0-0-2 | 100 | 0 | 0 | 1 |

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**Elective I**

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| 05ME 6011 | Metrology and Computer Aided Inspection |
| 05ME 6013 | Tooling for Manufacturing and Automation |
| 05ME 6015 | Industrial Safety Engineering |

**Semester 2** (Credits: 21)

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| Exam Slot | Course No: | Name | L- T - P | Internal  Marks | End Semester Exam | | Credits |
| Marks | Duration (hrs) |
| A | 05ME 6002 | Advanced Operations Research | 3-1-0 | 40 | 60 | 3 | 4 |
| B | 05ME 6004 | Precision and Micromachining | 3-0-0 | 40 | 60 | 3 | 3 |
| C | 05ME 6006 | Flexible Manufacturing Systems | 3-0-0 | 40 | 60 | 3 | 3 |
| D | 05ME 602x | Elective-II | 3-0-0 | 40 | 60 | 3 | 3 |
| E | 05ME 603x | Elective-III | 3-0-0 | 40 | 60 | 3 | 3 |
|  | 05ME 6066 | Seminar - I |  | 100 | 0 | 0 | 2 |
|  | 05ME 6088 | Mini Project | 0-0-4 | 100 | 0 | 0 | 2 |
|  | 05ME 6092 | Industrial Engineering and Computational Laboratory | 0-0-2 | 100 | 0 | 0 | 1 |

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**Elective II**

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| 05ME 6022 | Supply Chain Management |
| 05ME 6024 | Methods Engineering |
| 05ME 6026 | Simulation of Manufacturing Systems |

**Elective III**

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| 05ME 6032 | Advanced Material Joining and Testing |
| 05ME 6034 | Computer Aided Manufacturing |
| 05ME 6036 | Micro and Nano Manufacturing |

**Semester 3** (Credits: 14)

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| Exam Slot | Course No: | Name | L- T - P | Internal  Marks | End Semester Exam | | Credits |
| Marks | Duration (hrs) |
| A | 05ME 704x | Elective-IV | 3-0-0 | 40 | 60 | 3 | 3 |
| B | 05ME 705x | Elective-V | 3-0-0 | 40 | 60 | 3 | 3 |
|  | 05ME 7067 | Seminar - II | 0-0-2 | 100 | 0 | 0 | 2 |
|  | 05ME 7087 | Project (Phase 1) | 0-0-12 | 50 | 0 | 0 | 6 |

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**Elective IV**

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| 05ME 7041 | Production Scheduling |
| 05ME 7043 | Algorithms for Decision Making |
| 05ME 7045 | Statistical Methods for Engineering Research |

**Elective V**

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| 05ME 7051 | Sensors for Industrial Applications |
| 05ME 7053 | Management Information Systems |
| 05ME 7055 | Financial Engineering and Economics |

**Semester 4** (Credits: 12)

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| Exam Slot | Course No: | Name | L- T - P | Internal  Marks | End Semester Exam | | Credits |
| Marks | Duration (hrs) |
|  | 05ME 7088 | Project (Phase 2) | 0-0-21 | 70 | 30 | - | 12 |

12

Total: 68

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6001** | | **ADVANCED ENGINEERING MATERIALS AND PROCESSING** | 4-0-0-4 | 2015 | |
| **COURSE OBJECTIVES**   1. To analyze the structure and properties of intermatallics, maraging steel and super alloys. 2. To enable students to be more aware of the properties of advanced engineering materials such as composites and biomaterials and select the materials for various applications.   **COURSE OUTCOMES**  Upon completion of this course work, students should be   1. Familiar with a selection of advanced engineering materials and related processing techniques. 2. Aware of the scientific and technological aspects of these materials and processes. 3. Able to integrate the scientific and engineering principles underlying the four major elements: structure, properties, processing and performance related to material systems appropriate to the field. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Atomic structure, crystallography, imperfections, modes of plastic deformation, Frank and Read source, need of alloying, The Iron–Iron Carbide (Fe–Fe3C) phase diagram, heat treatment, strengthening mechanisms (Review only)  Intermetallics: property prediction, phase diagrams, Electron (or Hume - Rothery) compounds and Laves phase, AB2 structures.  Maraging steel: History of maraging steel development - reaction in austenite - reaction in martensite - austenite to martensite transformation – effect of aging time - effects of maraging with cobalt, cobalt free, molybdenum and other alloying elements - variation of mechanical properties: yield strength, hardness and fatigue - effect of precipitate size - fracture toughness and weldability, hardness variation in welded zone - manufacturing steps of rings- applications - special advantages and limitations - comparison of production sequence with high tensile steel.  High temperature super alloys: Characteristics of high-temperature materials- instances of superalloy component failures, gas turbine engine requirement- selection of materials for high-temperature applications,Larson–Miller approach for creep performance – justification for Nickel as a high-temperature material | | | | 9 |
| **II** | Physical metallurgy of nickel and its alloys: Composition–microstructure relationships in nickel alloys, FCC, gamma prime, gamma double prime phase, TCP phases, carbide and boride phases, grain-boundary carbides - Defects in Ni and its alloys - vacancies, shockley partial dislocations, superdislocations, stacking fault and antiphase boundary.  Strengthening effects in nickel alloys: strengthening by particles of the gamma prime phase, temperature dependence of strengthening, yielding effect in gamma prime alloys - creep behavior of nickel alloys: nickel and creep strengthening in nickel alloys by solid-solution strengthening and precipitation hardening.  Molybdenum: Ferromolybdenum -production of molybdenum – properties - effect of molybdenum alloying on hot strength, corrosion resistance, and toughness – applications - TZM,  TZC.  Niobium: Production of niobium - niobium alloys - niobium in steel making Ni alloys characteristics and applications  Biomaterials: - Requirements for biomaterials-Dental materials: Cavity fillers etc -The structure of bone and bone fracture-Replacement joints-Reconstructive surgery-Biomaterials for heart repair Modern physical metallurgy and materials engineering. | | | | 9 |
| **III** | Titanium: Basic Properties, Crystal Structure, Elastic Properties, Deformation Modes - binary phase diagram classification based on alloying elements-Basic Hardening Mechanisms: Alpha Phase, Beta Phase - Sponge Production- effect of forging temperature and forging pressure - closed die forgings - pickling of titanium - scrap recycling - closed die forging - problems in machining Titanium - shear bands - Heat treatment and microstructure obtainable - welding of titanium and defects.  Detailed discussions on Vacuum induction melting (VIM) - Conditions for freckle formation -  - Vacuum arc remelting (VAR), Control, and structure developed, melt-related defects - electroslag remelting (ESR), electrode quality melt-related defects - triple melting, super alloy cleanliness.  Ceramics: AX, AmXp, AmBmXp type crystal structures – imperfections in ceramics, stoichiometric defect reactions – stress strain behavior – applications. | | | | 10 |
| **IV** | Composites: Introduction to composites, constituent materials and reinforcing fibers -properties and characteristics glass, carbon, aramid, ceramic, silicon carbide, boron fibers - discontinuous and continuous reinforcements for metal-matrix composites -metallic matrices: aluminum alloys; low-density, high-modulus alloys; high-temperature aluminum; titanium alloys - ceramic matrices - carbon matrices - interfaces and interphases - interphase thermodynamics -surface modification strategies - interphase effects on fiber-matrix adhesion - interphase and fiber-matrix adhesion effects on composite mechanical properties | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Callister William. D., “Material science and engineering”, John Wiley. 2. Westbrook J. H., “Intermetallic compounds”, John Wiley. 3. American Society for Metals, “Source book of Maraging Steels”. 4. Richard K. Wilson (Editor), “Maraging steels - recent development and applications”, TMS Publication. 5. Roger C. Reed, “The Superalloys Fundamentals and Applications”, Cambridge university press. 6. Matthew J. Donachie, Stephen J. Donachie, Superalloys, “A Technical Guide”, ASM International. 7. Krishnan K Chawla, “Composite Materials: Science and Engineering”, Springer. 8. ASM hand book volume 21 -composites 9. Thermodynamics & Heat transfer, YunusCengel. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6003** | | **MANUFACTURING SYSTEMS MANAGEMENT** | 4-0-0-4 | 2015 | |
| **COURSE OBJECTIVES**   1. To understand the role of manufacturing systems management in the overall business strategy of the firm. 2. To estimate the requirements for establishing an industry including location and layout. 3. To study various planning techniques involved in successful manufacturing setups. 4. To study inventory control and the latest developments in inventory handling, including the basics of JIT and lean manufacturing.   **COURSE OUTCOMES**   1. Students will learn to critically observe management of manufacturing operations. 2. Students will understand the significance of facilities location and layout. 3. Students will have a basic understanding of current manufacturing control theories, EOQ models and JIT.   Students will be able to plan strategies for master production, MRP, billing and lot sizing. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction: Operations strategy, system concept of production, types of production system – job shop production – batch production – mass production, process planning, make or buy decisions, specific equipment selection, process plans, process reengineering.  Facilities location: Facility location factors, location analysis techniques – location factor rating – center of gravity technique – load distance technique. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Plant layout: Need for layout, objectives, types of layout, layout design process, layout design cycle, data collection, equipment requirement, activity analysis, REL diagram, employee requirement, development of layout - block plan, selection, specification, evaluation.  Layout design procedures: ALDEP, CORELAP and CRAFT | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Aggregate planning: Aggregate planning strategies – heuristic method for aggregate planning.  Materials requirement planning: Objectives, master production schedule, bill of materials, MRP calculations, lot sizing in MRP - economic order quantity method - minimum cost per period method - periodic order quantity method - least unit cost method - part period balancing, Evolution from MRP to manufacturing resource planning (MRP II).  Enterprise resource planning (ERP):Overview of ERP, benefits of ERP, ERP and functional units. | | | | 10 |
| **IV** | Inventory analysis and control: Definitions – inventory control systems - ABC inventory System - EOQ models for purchased parts and manufactured parts – quantity discounts – reorder point - inventory models under uncertainty.  Just in time manufacturing: Introduction, elements of JIT, pull versus push method, kanban systems. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. R. Paneerselvam, “Production and operations management”, PHI, 2010 2. Roberta S. Russell and Bernard W. Taylor III, “Operations management”, PHI, 2007 3. P. B. Mahapatra, “Operations management: a quantitative approach”, PHI, 2010 4. Francis, R. L. and White, J. A., “Facility layout and location: an analytical approach”, Prentice-Hall Inc., New Jersey, 1974. 5. Moore, J. M., “Plant layout and design”, Macmillan Company, New York, 1970. 6. Apple, J. M., “Plant layout and material handling”, John Wiley and Sons, New York. 7. Tompkins and White, “Facilities planning”, John Wiley and Sons, New York. 8. Brady, “Enterprise resource planning”, Thomson Learning, 2001 9. S. Sadagopan, “ERP: a managerial perspective”, Tata McGraw-Hill, New Delhi 1999. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6005** | | **COMPUTER AIDED DESIGN IN MANUFACTURING** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To provide an overview of the CAD systems 2. To discuss computer graphics and graphics transformations involved in CAD. 3. To introduce the concepts of geometric modeling and parameter design. 4. To provide an introduction to Finite Element Analysis.   **COURSE OUTCOMES**   1. Understand the use of computer graphics and geometric modelling techniques in CAD. 2. Understand the use of Finite Element Analysis in CAD applications. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Overview of CAD systems: Conventional and computer aided design processes – advantages and disadvantage – CAD hardware and software – analytical and graphics packages – networking of CAD systems.  Computer graphics and graphics transformation: Image processing – transport of graphics data – graphic standards – display and viewing – transformations – customizing graphics softwares. | | | | 9 |
| **II** | Geometric modeling: Wire frame, surface and solid modeling – applications and advantages –Boolean operations – half-spaces – filleting of edges of solids – boundary representations – constructive solid geometry – sweep representation | | | | 9 |
| **III** | Parametric design and object representation: Types of co-ordinate system – parametric design – definition and advantages – parametric representation of analytic and synthetic curves – parametric representation of surfaces and solids – manipulations.  Mechanical assembly – mass property calculation. | | | | 10 |
| **IV** | Introduction to finite element analysis: Basic steps in finite element problems formulation – element type and characteristics – element shapes – co-ordinate systems – 1D link elements and beam elements – shape functions – stiffness matrices – direct stiffness method – 2 D elements – axisymmetric elements – plane stress problem – higher order elements. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| REFERENCES:  1. New man & Sproull, Principles of interactive graphics, McGraw Hill. 2. C. S. Krishnamoorthy and S. Rajeev, Computer aided design, Narosa Publishing House, 1991 3. Ibrahim Zeid, CAD/CAM theory and practice, McGraw Hill Inc, 1991 4. Vera B. Anand, Computer graphics and geometric modelling for engineers, John Wiley & Sons Inc., 1993 5. Sandhu Singh, Computer aided design and manufacturing, Khanna Publishers, 1998 6. User’s Manuals for Ansys, Adams, Pro/Engineer, Cadds 5 and Autocad softwares. 7. R. D. Cook, Concepts and applications of finite element analysis 8. Daryl L. Logan, A first course in the finite element method 9. David V. Hutton, Fundamentals of finite element analysis 10. David F. Rogers and J. Alan Adams, Mathematical elements for computer graphics, Second Edition, McGraw Hill, 1990 | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6007** | | **QUALITY ENGINEERING AND MANAGEMENT** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce the philosophy and core values of quality management. 2. To develop an understanding of quality management principles, frameworks, tools and techniques for effective real life applications in industry 3. To study different methods for improving quality.   **COURSE OUTCOMES**  Upon successful completion of the module students will be able to:   1. Develop an understanding on quality management philosophies and frameworks 2. Develop in-depth knowledge on various tools and techniques of quality management 3. Learn the applications of quality tools and techniques in both manufacturing and service industry | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Quality: Defining quality – philosophies of quality ‘gurus’- dimensions of quality - measures of quality – cost of quality – direct costs & indirect costs – ‘defectives’ and its significance - traditional model and emerging model of ‘cost-of-quality.’  Continuous process improvement: PDSA cycle – problem solving methodology | | | | 9 |
| **II** | Statistical process control: Statistical tools - control charts and use of probability distributions, process capability.  Acceptance sampling: Lot-by-lot acceptance sampling by attributes – fundamental concepts, statistical aspects: operating characteristic curve, producer’s risk and consumer’s risk, AQL, LQ, AOQ, ASN, ATI – sampling plan design. | | | | 9 |
| **III** | Taguchi methods: Loss functions – signal-to-noise ratio - process optimization and robust product design using orthogonal arrays,parametric and tolerance design.  Quality function deployment: Concept - house of quality – QFD process. | | | | 10 |
| **IV** | Total quality management (TQM): Definition - basic concepts – strategies.  Six sigma methodology: Basic concepts – DMAIC problem solving technique.  Quality system and standards: An overview of ISO 9000 and ISO 14000 series of standards | | | | 8 |
| **REFERENCES:**   1. Dale H. Besterfield, “Quality control”, Person Education, New Delhi, 2006. 2. Dale H. Besterfield, Carol Besterfield, Glen H. Besterfield & Mary Besterfield, “Total quality management”, Person Education, New Delhi, 2008. 3. R. Subburaj, “ISO 9000: Path to TQM”, Allied Publishers Limited, New Delhi, 1997 4. Bank J., “The essence of total quality management”, Prentice Hall 5. Dale B. G., “Managing quality”, Prentice Hall 6. A.V. Feigenbaum, “Total quality control”, McGraw Hill 7. G. L. Taguchi and Syed et. al., “Quality engineering production systems”, McGraw Hill 8. Zaidi, “SPC - concepts, methodology and tools”, Prentice Hall 9. Perry L Johnson, “ISO 9000”, McGraw Hill | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6011** | | **METROLOGY AND COMPUTER AIDED INSPECTION** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To familiarize the basic concepts of metrology, use of statistics in metrology and types of errors in precision measurements. 2. To acquaint the students with the metrology of gears and methods of measurement in testing of machine tools and measurement of gears. 3. To discuss Computer Aided Inspection (CAI) techniques.   **COURSE OUTCOMES**  Upon completion of this course work, students should have:   1. Have up to date knowledge about Metrology and Inspection and their applications in industries. 2. Understand the role of computers in metrology. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Type of errors:-catastrophic errors, alignment errors, combined sine and cosine errors, alignment of spherical end gauges; optical principles of projector, microscope, telescope, collimator, autocollimator and optical flat etc ; errors due to ambient conditions and errors due to elastic deformation; effects of supports; scale, reading, measuring errors; compound errors.  Mathematical concepts in metrology: - statistical concepts, limiting mean, range, variance and standard deviation, normal distribution, confidence interval and limits, precision and accuracy, statistical analysis of measurement data and control chart techniques.  Pneumatic comparators: - general design features, air gauge circuits, air gauge tooling, amplification selection, air gauge mastering, automatic gauging for inspection, machine control and assembly. | | | | 9 |
| **II** | Measurement of gears:-involute curve, involute function, standard proportions, helical gears, under cutting in gear teeth and addendum modification, dual flank test, single flank test -tooth thickness measurement:-tooth thickness at a pitch line, constant chord, base tangent method, measurement of over rollers - gear pitch measurement: - tooth to pitch measurement, cumulative pitch error measurement – testing involute form – allowable errors in spur gear. | | | | 9 |
| **III** | Machine tool testing:- lathe tests:- spindle axis parallel to bed, cross slide perpendicular to spindle axis, accuracy of pitch of lead screw etc – milling machine tests:- table surface parallel to guide ways, centre tee-slot parallel to table movement and square with spindle axis, cross travel of table parallel to spindle axis etc – radial drill tests:- saddle and arm movements parallel to base plate, spindle and feed movement square with base plate, other machines and methods – testing of measuring instruments:- plate square testing, angle between centre lines of holes, spines, gear tooth measurement, testing of try square, checking micrometer measuring faces, calibration of micrometer screw, checking of an autocollimator, optical square, calibration of polygon and circular table. | | | | 10 |
| **IV** | Laser metrology – applications of lasers in precision measurements - Co-ordinate measuring machine – contact and non-contact cmm – causes of errors – accuracy specifications – contact and non-contact probes - Calibration of CMM – measuring scales – Moiré fringes in linear grating – advantages and applications of CMM - Machine vision system – image formation – binary and grayscale image – image histogram – histogram operations – pixel point processing and pixel group processing – image sharpening and smoothing – edge detection and enhancement. | | | | 8 |
| **REFERENCES:**   1. ASME, Hand book of industrial metrology 2. Hume, “Metrology”, McDonald 3. Robert J. Hocken, Paulo H. Pereira, “Coordinate measuring machines and systems”, Second Edition, [CRC](https://books.google.co.in/url?id=TGzLBQAAQBAJ&pg=PA140&q=http://www.crcpress.com&linkid=1&usg=AFQjCNG9sb7YhmU3fNfZ2en-vuWw5jeLKQ&source=gbs_pub_info_r) 4. Sharp, “Metrology”, ELBS 5. Taher, “Metrology”, ELBS   Ted Busch, “Fundamentals of dimensional metrology”, Third Edition, Delmar Publishers | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6013** | | **TOOLING FOR MANUFACTURING AND AUTOMATION** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To analyse the various locating techniques, clamping methods and workholding devices. 2. To introduce the concepts and background information related to the design of jigs and fixtures. 3. To discuss the wear and vibration in machine tools.   **COURSE OUTCOMES**   1. Basic understanding of the various considerations in tooling such as design of jigs and fixtures, location and clamping, vibration in machine tools etc. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Locating methods:Methods, degrees of freedom, pins, vertical holding, radial location, diamond pins - principles of pin location – V locators - tool forces in different processes - principle of clamping: clamping types – quick action clamping, power clamping etc. - elements - work holding principle for irregular and round surfaces - rigid and elastic holding - types of work holders – work holder selection – analysis of clamping forces: strap clamp calculations, clamping force analysis of toggle and screw clamp - Indexing devices: linear indexing, rotary indexing etc. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Drill jigs: Types - leaf jigs, box jigs, channel jigs, template jigs and indexing jigs – chip formation in drilling – types of drill bushings.  Types of fixtures: Economics of fixture - vise fixtures – types and details of milling fixtures, requirements of milling fixtures, special vice jaws - facing, straddle, gang, index, rotary and reciprocal milling fixtures - types and details of boring, slotting, broaching fixtures - types and details of lathe fixtures, chucks, face plate, collets, mandrels, etc. - types and details of grinding fixtures. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Welding fixtures: Gas, arc and resistance welding fixtures – tooling for soldering and brazing - modern jigs, hydraulic and pneumatic fixtures - tool holding methods for numerical control - tool magazines  Calculation of tool forces in lathe, broaching, shaping and milling operation - determination of power consumption in cylindrical grinding, drilling, broaching, shaping and milling process –thrust on a drill. | | | | 10 |
| **IV** | Machine tool slide ways: Different shapes – materials – hydrodynamic action - machine tool guides: wearing of guides- guide materials – stick slip motion in guides - temperature deformation of guides – liquid friction in guides – determination of pressure on guides – accuracy and wear of guides - design of guides under hydrostatic lubrication.  Vibration of machine tools: Effects of vibration – sources of vibration- single and two degree of freedom chatter theory – chatter in lathe, radial drilling, milling and grinding machines – elimination of vibration – vibration isolated tool holders. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Edward G. Hoffman, “Jig and fixture design”, Delmar Learning 2. Basu S. K., “Design of machine tools”, Allied publishers, Bombay, 1965 3. Boyes E. William, “Jigs & fixtures & gauges”, 1st Edition, SME, 1986 4. Donaldson, Lecain and Goold, “Tool design”, McGraw Hill, New York, 1976 5. Erik Karl Henriksen, “Jig and fixture design manual”. 6. Gopal Chandra Sen and Amitabha Bhattacharya, “Principles of machine tools”, New Central Book Agency, Calcutta, 1967 7. Henriksen E. K., “Jig and fixture design manual”, Industrial Press, New York, 1973 8. Joshi P. H., “Jigs & fixtures”, Tata McGraw Hill Pub. Co. Ltd., 1999 9. Koenigsberger F, “Design principles of metal cutting machine tools”, Macmillan 10. “Tool and manufacturing engineers handbook”, Volume 1: Machining, SME 11. “Die design handbook”, 3rd Edition, SME, 1990 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6015** | | **INDUSTRIAL SAFETY ENGINEERING** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To enable students to be aware of the need for safety in industrial premises. 2. To study accident prevention and operational safety. 3. To discuss occupational and work related diseases, prevention and control. 4. To introduce fire safety, fire protection systems and explosion control.   **COURSE OUTCOMES**   1. Students will recognize the importance of safety in industry. 2. Students will understand types of safety measures to be taken in various risks. 3. Students will be able to understand fire engineering and steps to be taken for preventing explosion. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
|  | Safety management: Need for safety - safety and productivity - planning for safety -formulation of safety policy - safety management techniques - job safety analysis - safety sampling technique - incident recall technique - plant safety inspection - safety organizations and its functions.  Accident prevention: Nature and causes of accidents - accident proneness - cost of accidents - accident prevention methods - accident reporting and investigation - personal protective equipments - safety education and training - damage control and disaster control. | | | | 9 |
| **II** | Operational safety: General safety considerations in material handling – manual and mechanical - safety in machine shop – safety in use of hand and portable (power) tools - safety in use of electricity – safety in welding and cutting – principles of guarding – safety in grinding - safety in heat treatment shop - safety in gas furnace operation. | | | | 9 |
| **III** | Occupational health and hygiene: Concept and spectrum of health - levels of prevention - functional units of occupational health service - activities of occupational health unit - occupational and work related diseases such as silicosis – asbestosis - lead, nickel, chromium and manganese toxicity - prevention and control - gas poisoning - effects and prevention - hearing conservation programme - physical and chemical hazards - control measures. | | | | 10 |
| **IV** | Fire engineering and explosion control: Fire triangle - classification of fires - fire properties of solid, liquid and gas - building evaluation for fire safety - fire load - fire resistance materials and fire testing - structural fire protection - exits and egress - industrial fire protection systems – sprinkler – hydrants - portable extinguishers - fire suppression systems - detection systems - principles of explosion - detonation and blast waves - explosion venting - explosion parameters - explosion suppression systems based on CO2 and halon. | | | | 8 |
| **REFERENCES:**   1. Heinrich H. W, “Industrial accident prevention”, McGraw Hill Company, New York, 1980 2. Frank P. Lees, “Loss prevention in process industries”, Vol. I, II & III, Butterworth, London, 1980 3. Brown D. B, “System analysis and design for safety” Prentice Hall, New Jercy, 1976 4. Derek James, “Fire prevention hand book”, Butter Worths and Company, London, 1986 5. “Accident prevention manual for industrial operations”, National Safety Council, Chicago, 1989 6. Clayton and Clayton, “Patty’s industrial hygiene and toxicology”, Vol. I, II & III, Wiley Interscience | | | | | |
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| **05ME 6077** | | **RESEARCH METHODOLOGY** | 1-1-0-2 | 2015 | |
| **COURSE OBJECTIVES**   1. To generate awareness about the importance, types and stages of research. 2. To introduce the methods for data collection, analysis, interpretation and presentation of the results.   **COURSE OUTCOMES**  The students will be able to understand   1. The significance of different types of research and its various stages 2. The different methods of data collection 3. Different methods for analyzing data and interpreting the results. 4. The proper way of reporting and presenting the outcome. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| I | Research: Meaning & objectives – types of research - identification, selection and formulation of research problem - research design - review of literature. Data collection & presentation: Primary & secondary data - collection methods. Basic statistical measures: Measures of central tendency, variation and skewness. | | | | 9 |
| **II** | Probability:Definition – discrete and continuous probability distributions: binomial, poison, uniform, exponential and normal distributions. Sampling technique: Sampling methods, sampling distribution of mean, variance and proportion, confidence interval estimation, determination of sample size. | | | | 9 |
| **III** | Testing of hypothesis: Fundamentals of hypothesis testing – procedure of hypothesis testing - testing of mean, proportion and variance: one-tailed and two-tailed tests – chi-square test for checking independence of categorized data - goodness of fit test. Test for correlation and regression. | | | | 10 |
| **IV** | Non - parametric tests: One sample tests - sign test, chi-square test, Kolmogorov-Smirnov test, run test for randomness – two sample tests: sign test, median test, Mann-Whitney U test – K-samples tests: median tests, Kruskal-Wallis test. Interpretation and report writing: Meaning of interpretation, techniques of interpretations - types of report, layout of research report. | | | | 8 |
| **REFERENCES:**   1. Panneerselvam, R., “Research methodology”, Prentice Hall of India, New Delhi, 2011 2. Kothary, C. R., “Research methodology: methods and techniques”, New Age International, New Delhi, 2008 3. Goddard, W. and Melville, S., “Research methodology – an introduction”, Juta & Co. Ltd., Lansdowne, 2007 4. Miller and Freund, “Probability and statistics for engineers”, Prentice Hall of India Private Limited, New Delhi | | | | | |

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| COURSE CODE | | COURSE NAME | | | L-T-P-C | | YEAR | |
| **05ME 6091** | | **MANUFACTURING AND PRECISION ENGINEERING LABORATORY** | | | 0-0-2-1 | | 2015 | |
| 1. Computer aided drafting. 2. Solid modeling: part creation, surface generation and assemblies of parts. 3. Surface modeling. 4. FEM: creation of model, use of different elements, treatment of different loads and boundary conditions. 5. Determination of cutting force in turning, drilling and grinding using tool force dynamometer. 6. Study and programming of CNC production machines. 7. Study and programming of robots. 8. Study and measurements of components using CMM. 9. Surface roughness measurements using light, stylus, interference methods. 10. Metallographic studies using metallurgical microscope. 11. Determination of wear and coefficient of friction of the given specimen using pin on disc tester. 12. Study and use of laser interferometer for calibration of linear measurements. 13. Study of slip gauges – wringing – surface roughness - standards. 14. Study of surface plates, straight edges, angle plate, V-block etc - use of desiccants, corrosion preventing coatings etc. 15. Measurement of out of roundness using roundness measuring instrument - V block and dial indicator etc. - reasons for out of roundness etc. 16. Measurements of straightness using sprit level, auto collimator etc. 17. Measurement of thread parameters using three wire method etc. 18. Measurement of tool angles of single point tool using tool maker’s microscope. 19. Measurement of gear parameters using profile projector. 20. Evaluation of straightness error using autocollimator, sprit level, straight edge etc. 21. Experiments on limits and fits. 22. Study and use of ultrasonic flaw detector. | | | | | | | | |
| COURSE CODE | | | COURSE NAME | L-T-P-C | | YEAR | | |
| **05ME 6002** | | | **ADVANCED OPERATIONS RESEARCH** | 3-1-0-4 | | 2015 | | |
| **COURSE OBJECTIVES**   1. To analyze and solve linear models used in Operations Research including linear programming, network flow, and integer programming. 2. To solve practical problems applying dynamic programming and queuing theory 3. To introduce non linear programming and basic algorithms for solving NLP.   **COURSE OUTCOMES**  Upon completion of the course students will be able to:   1. understand Advanced Operations Research models and apply them in solving practical problems in industry; 2. formulate a managerial decision problem into a mathematical model | | | | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | | | | HRS |
| **I** | Linear programming: Problem formulation, graphical solution, simplex method, artificial starting solution, dual simplex method, duality theory, sensitivity analysis  Parametric linear programming: Introduction, changes in objective function coefficients, changes in right-hand side constants of constraints. | | | | | | | 9 |
| **II** | Integer programming: The branch and bound technique, Gomory’s cutting plane method  Network analysis: Shortest route problem: systematic method - Dijkstra’s algorithm - Floyd’s algorithm, minimal spanning tree problem: PRIM algorithm – Kruskal’s algorithm, maximum flow problem. | | | | | | | 9 |
| **III** | Deterministic dynamic programming: Cargo loading model, reliability improvement model, single machine scheduling model, capital budgeting problem.  Queuing theory: Introduction to queuing system, terminologies, classification of queuing models – (M/M/1) : (GD/α/α), (M/M/C) : (GD/α/α), (M/M/1) : (GD/N/α), (M/M/C) : (GD/N/α), (M/M/C) : (GD/N/N), (M/M/1) : (GD/N/N) models. | | | | | | | 10 |
| **IV** | Goal programming: Goal programming formulation, simplex method for solving goal programming.  Nonlinear programming:Lagrangean method, Kuhn-Tucker conditions, quadratic programming. | | | | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | | | | |
| **REFERENCES:**  Hamdy A. Taha, “Operations research”, Pearson, 2004  R. Paneerselvam, “Operations research”, PHI, New Delhi, 2008  Ravindran, Phillips and Solberg, “Operations research principles and practice”, Willey and Sons 1987. | | | | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6004** | | **PRECISION AND MICROMACHINING** | 3-0-0-0 | 2015 | |
| **COURSE OBJECTIVES**   1. To discuss the principles of micromachining. 2. To introduce the basic concepts in laser beam machining. 3. To study the various advanced finishing processes and their applications.   **COURSE OUTCOMES**  On successful completion of this course, students will be able to:   1. Gain an insight into the various aspects of laser beam machining. 2. Have a good understanding of the theories of cutting and chip formation in micro and nano engineering. 3. Acquire knowledge in the mechanism of material removal and machinability of materials in advanced finishing processes. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Laser beam machining: Lasers basics - integration of laser system for cutting operation - principles of laser material removal – detailed discussion on process analysis, absorbed laser power at the cut front, exothermic heat in reactive laser cutting - characteristics of cut front, temperature at cut front, melt film thickness, melt flow velocity, mobility of cut front- characteristics of cut surface, striation, thermal dynamic instability, hydrodynamic instability - heat-affected zone - processing parameters, cutting speed, laser beam, polarization of beam, wavelength of laser beam, pulsed laser beam etc, gas nozzle etc - workpiece aspects for laser beam machining, workpiece thickness, workpiece materials. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Mechanical micromachining: microfluidic systems - theory of micromachining; micromilling force analysis, initial chip curl modeling, burr formation in micromachining - micromachining tool design - high speed air turbine spindles- mechanical design of high-speed rotors, basic geometry of the rotor, rotor with fillet surfaces. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Nanomachining: Introduction, nanometric machining, theoretical basis of nanomachining, cutting force and energy, cutting temperature, chip formation and surface generation, minimum undeformed chip thickness, critical cutting edge radius, properties of workpiece materials, comparison of nanometric machining and conventional machining- implementation - single point diamond turning. | | | | 10 |
| **IV** | Advanced finishing processes (AFPs), abrasive flow machining (AFM), magnetic abrasive finishing (MAF), elastic emission machining (EEM), ion beam machining (IBM), microhoning , superfinishing and chemical mechanical polishing (CMP). Micromachining by photonic beams- excimer laser- model construction of laser dragging, numerical simulation of dragged profile. Micromanufacturing for document security: Optically variable device - ODV foil microstructures- generic OVD microstructures- nano CODES. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Paulo Davim J, “Nontraditional machining processes”, ISBN 978-1-4471-5179-1, Springer-Verlag, London, 2013. 2. Hong Hocheng and Hung-Yin Tsai, “Advanced analysis of nontraditional machining”, Springer. 3. Nitaigour Premchand Mahalik, “Micromanufacturing and nanotechnology” 4. Joseph McGeough, “Micromachining of engineering materials mechanical engineering”, ISBN: 0-8247-0644-7. 5. M. Kahrizi, “Micromachining techniquess for fabrication of micro, nano structures”. 6. Mark J. Jackson, “Micro and nanomanufacturing”, Springer. | | | | | |
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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6006** | | **FLEXIBLE MANUFACTURING SYSTEMS** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To provide an understanding of the concepts of flexible manufacturing systems, their components and operational decisions required for controlling such systems. 2. To specify the types of quantitative analysis that may be used with regard to FMS. 3. To study the fundamental concepts and programming of a Programmable Logic Controller (PLC).   **COURSE OUTCOMES**  Upon completion of this course work, students should be able to:   1. Perform modeling, design and simulation of flexible manufacturing systems. 2. Gain insight about the research areas related to FMS and real-time shop floor control. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to FMS: Definition of FMS – types and configuration concepts – types of flexibility. Functions of FMS host computer – FMS host and area controller function distribution.  Development and implementation of FMS: Planning phases – integration – system configuration – FMS layouts – simulation – FMS project development steps. Project management – equipment development – host system development – planning - hardware and software development. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Pioneering integrated systems – different flexible systems: molins, chalmers etc – different pallets and fixtures for prismatic and turned parts – prismatic parts machines.  Planning and scheduling of FMS: Quantitative Analysis of FMS – Bottleneck Model – Terminology and symbols, FMS Operational parameters, System performance measures –Extended Bottleneck model- Sizing the FMS - problems. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Distributed numerical control: DNC system – communication between DNC computer and machine control unit – hierarchical processing of data in DNC system – features of DNC system specific to FMS.  Automated material handling: Functions - types – quantitative analysis of material handling equipments. Design of conveyors and AGV systems.  Automated storage: Storage system performance – AS/RS – carousel storage system – WIP storage – interfacing handling and storage with manufacturing. | | | | 10 |
| IV | Programmable logic controllers in FMS: Role of PLCs in Manufacturing and Assembly operations in a CIM environment – PLC Input instructions, Outputs. PLC Timer and Counter functions – Creating relay logic diagrams and screen patterns for various operations in FMS from their process control descriptions.  Data base in FMS: Manufacturing data systems and data flow-CAD and CAM considerations for FMS – data base systems.  Design of automated assembly systems - FMS case studies in aerospace machining, sheet metal fabrication applications - Toyota production system - The Rover LM-500 FMS – The HNH (Hattersley Mewman Hender) FMS etc. | | | |  |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Parrish D. J., “Flexible manufacturing”, Butterworth – Heinemann Ltd, 1990 2. Groover M. P., “Automation, production systems and computer integrated manufacturing”, Prentice Hall India (P) Ltd., 2002 3. Shivanand H. K., Benal M. M and Koti V, “Flexible manufacturing system”, New Age International (P) Limited. Publishers, 2006 4. Kusiak A., “Intelligent manufacturing systems”, Prentice Hall, Englewood Cliffs, NJ, 1990 5. Joseph Talavage and Roger G. Hannan, Flexible Manufacturing Systems in practice, Marcel Dekker, Inc. New York, 1988. 6. Considine D. M. & Considine G. D., “Standard handbook of industrial automation”, Chapman and Hall, London, 1986 7. Viswanadhan N. and Narahari Y., “Performance modeling of automated manufacturing systems”, Prentice Hall India (P) Ltd., 1992 8. John W. Webb and Ronald A. Reis “Programmable Logic Controllers”, Prentice Hall India (P) Ltd., 2006. 9. Ranky P. G., “The design and operation of FMS”, IFS Pub, U. K, 1998 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6022** | | **SUPPLY CHAIN MANAGEMENT** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce the major elements of supply chain and the need for supply chain management. 2. To study the role of forecasting and inventory management in supply chain. 3. To discuss sourcing, transportation and logistics decisions in supply chain management.   **COURSE OUTCOMES**   1. Students will be able to understand how supply chain strategy can provide a competitive edge for organizations 2. Students will learn about the importance of supply chain management and how to apply decision making techniques in an integrated supply chain environment. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to supply chain management: Supply chain basics, decision phases in supply chain, supply chain flows, supply chain efficiency and responsiveness, supply chain integration, process view of a supply chain, uncertainties in supply chain, key issues in supply chain management, drivers of supply chain performance. Supply chain coordination, bullwhip effect, developing relationships in the supply chain, resolving conflicts in supply chain relationships, role of information technology in supply chain | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Demand forecasting in supply chain: Role of forecasting in supply chain, components of a forecast, forecasting methods, estimating level, trend and seasonal factors, Holt’s model, Winter’s model, measures of forecast error.  Role of aggregate planning in supply chain: Aggregate planning strategies, managing supply and demand in supply chain. | | | | 9 |

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| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Supply chain inventory: Role of cycle inventory in supply chain, economies of scale, lot sizing for a single product, lot sizing for multiple products, quantity discounts, trade promotions, price discrimination. Role of safety stock in supply chain, determining appropriate level of safety inventory, inventory replenishment policies, measures of product availability. | | | | 10 |
| **IV** | Sourcing decisions in supply chain: Supplier selection and contracts, design collaboration, making sourcing decisions in practice.  Transportation decisions: Role of transportation in supply chain, factors affecting transportation decisions. Routing and scheduling in transportation.  Logistics: Definition, logistics and SCM, international considerations, inbound logistics, internal logistics and outbound logistics. Reverse logistics, green supply chain. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Sunil Chopra and Peter Meindl, “Supply chain management - strategy planning and operation”, PHI 2. Handfield R. B., Nichols Jr. E. L., “Introduction to supply chain management”, Pearson Education 3. Raghuram R. and Rangaraj N., “Logistics and supply chain management”, Macmillan, 2001 4. Simchi-Levi, D., Kaminsky, P., and Simchi-Levi, E., “Designing & managing the supply chain: concepts, strategies & case studies.” 2nd Edition, Tata McGraw-Hill, 2003 5. Agarwal D. K., “A text book of logistics and supply chain management”, Macmillan, 2003 6. Srinivasan, G., “Quantitative models in operations and supply chain management”, PHI | | | | | |
| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6024** | | **METHODS ENGINEERING** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce work study as a means for improving productivity. 2. To study the various techniques used for method study and work measurement. 3. To study the significance of ergonomics and work place design.   **COURSE OUTCOMES**  On successful completion of this course, students will be able to:   1. Gain an insight into the various techniques for improving the way a job is done. 2. Understand the significance of human integration and how workers can most effectively perform their assigned tasks using methods engineering techniques . | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Productivity and work study: Introduction to productivity – definitions – productivity at the enterprise level – productivity measurements - factors contributing to productivity improvement – techniques for productivity improvement. Introduction to work study – definition – procedure – human factors in work study – influence of working conditions on work study. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Method study: Definition and objectives – procedure – process analysis – process chart – outline process chart – flow process chart – string diagram – travel chart – multiple activity chart – two handed process chart - principles of motion economy – micro motion study – simo chart – memo motion study. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Work measurement: Definition and purpose – time study equipment – selecting and timing the job - establishment and maintenance of time standards – allowances and performance rating – pre-determined time standards – standard data. Work sampling – definition – procedure – determination of sample size – procedure for selecting random observations. | | | | 10 |
| **IV** | Ergonomics: Definition, objectives and applications – man-machine systems – characteristics – purpose – operational functions and components – types of systems. Information displays – visual displays – quantitative and qualitative displays – auditory and tactual displays – design of controls – relationship between controls and displays. Workplace design – design considerations – workplace layout. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. “Introduction to work study “, ILO Geneva, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, Third Revised Edition, 1991. 2. Barnes, Raeph M., “Motion and time study – design and measurement of work”, John Wiley & Sons, New York, 1990. 3. Mc. Cormick, E. J., “Human factors in engineering and design”, Tata McGraw-Hill. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6026** | | **SIMULATION OF MANUFACTURING SYSTEMS** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce system simulation and concepts in discrete event simulation. 2. To discuss input modelling for simulation, validation of simulation models and output analysis 3. To perform Simulation modelling and analysis of manufacturing systems   **COURSE OUTCOMES**  Upon completion of this course work, students should   1. Gain an insight into how simulation modeling can aid in effective decision-making. 2. Understand Simulation model building aspects of discrete systems | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | System concept: Systems and system environment, components of a system, discrete and continuous systems, systems approach to problem solving, types of system study, system analysis, system design and system postulation, system modelling, types of models.  System simulation: Technique of simulation, comparison of simulation and analytical methods, types of system simulation, steps in simulation study, Monte Carlo simulation.  Concepts in discrete event simulation: Event scheduling/time advance algorithm, modelling world views, simulation programming tasks, comparison and selection of simulation languages. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Random number generation: Techniques for generating random numbers, linear congruential method, test for random numbers, frequency tests, run tests, tests for autocorrelation, gap test, and Poker test.  Random variate generation: Inverse transformation technique, exponential, uniform, weibull, triangular, empirical-discrete and continuous distributions. Convolution method, acceptance - rejection technique.  Input modelling for simulation: Data collection, identifying the distribution with data, parameter estimation, goodness of fit test, Chi square, Klomogrov and Smirnov tests, selecting input model when data are not available. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Verification and validation of simulation models: Verification of simulation models, calibration and validation of models, face validity, validation of model assumption, validating input-output transformation, input-output validation using historical input data.  Output analysis for a single model: Measures of performance and their estimation, point estimation, interval estimation, output analysis for terminating simulations and steady state simulations. | | | | 10 |
| **IV** | Simulation modelling and analysis of manufacturing systems: Objectives, performance measures, issues in simulation of manufacturing systems, simulation software for manufacturing 22 applications, simulation of job shop manufacturing systems, simulation modelling and analysis of single server and single queue systems, inventory systems and pert networks. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Banks, J., Carson, J. S., Nelson, B. L., and Nicol, D. M., “Discrete-event system simulation”, Third Edition, Pearson Education, Inc., 2001 2. Gordon G., “System simulation”, Prentice Hall Ltd. 1991 3. Deo, N., “System simulation with digital computer”, Prentice Hall of India, 1997 4. Askin R. G. and Standridge, C. R., “Modelling and analysis of manufacturing systems”, John Wiley & Sons, 1993. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6032** | | **ADVANCED MATERIALS JOINING AND TESTING** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To study the metallurgy of weld, weld defects, destructive and non destructive testing of welds and various welding processes. 2. To discuss the various joining techniques other than welding.   **COURSE OUTCOMES**   1. In depth knowledge on the various aspects of welding. 2. Knowledge about the different material joining techniques used in industry. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction: Classification – heat sources – metallurgical effect of weld – residual stresses: formation and relieving – capillary and welding action – temperature range – filler material and fluxes – types of joints and welding positions – weldability: design, process and metallurgical consideration – testing and improvement. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Conventional joining techniques: Bolting – riveting – soldering – blazing – adhesive bonding – diffusion bonding – mechanical joining. Fusion welding: Oxyacetylene welding – SMAW – GTAW – GMAW – FCAW – SAW – ESW – High energy beam welding: EBW, LBW, PAW – friction stir welding. Output parameter variation – advantages and disadvantages – applications. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Destructive and non-destructive tests for welds: Introduction – need – principles – applications – destructive tests: tensile, bend, impact, hardness, fatigue, cracking, etching. Non-destructive tests: Visual, dye penetrants, magnetic particle, acoustics, pressure, radiographic, ultrasonic, eddy current. | | | | 10 |
| **IV** | Responses of materials to welding: Microstructural changes – distortion – defects: undercuts – overlaps – grain growth – blowholes – inclusions – segregation – lamellar tearing – porosity. Remedies: Edge preparation – alignment – control of heat input – preheating – peening – heat treatment – jigs and fixtures – number of passes. | | | | 8 |
| **END SEMESTER EXAM (ALL Modules)** | | | | | |
| **REFERENCES:**   1. Richard L. Little, “Welding and welding technology”, 2000 2. S. W. Nadkarni, “Welding technology” 3. J. F. Lacaster, “Metallurgy of welding, soldering and brazing”, Pergamon Press 4. “Welding handbooks”, American Welding Society 5. “Metal handbooks”, American Society of Metals 6. O. P. Khanna, “Text book of welding technology”, Dhanpat Rai & Sons 7. Carry, “Modern welding technology”, Prentice Hall | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6034** | | **COMPUTER AIDED MANUFACTURING** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce the design features of CNC machines and their control systems. 2. To study part programming for CNC lathe and machining centre.   **COURSE OUTCOMES**  Upon completion of this course work, students should have:   1. Basic understanding of the design features of CNC machines. 2. The ability to generate part programs to machine parts to specifications in CNCs and machining centres. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction and design features of CNC machines: Working principles of typical CNC lathes, turning centre, machining centre, CNC grinders, CNC gear cutting machines, wire cut EDM, turret punch press, CNC press brakes etc. Selection of CNC machine tools. Structure, drive kinematics, gear box, main drive, feed drive, selection of timing belts and pulleys, spindle bearings arrangement and installation. Re-circulating ball screws, linear motion guide ways, tool magazines, ATC, APC, chip conveyors, tool turrets, pneumatic and hydraulic control systems. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Control systems and interfacing: Open loop and closed loop systems, microprocessor based CNC systems, block diagram of a typical CNC system, description of hardware and software interpolation systems, standard and optional features of a CNC control system, comparison of different control systems. Feedback devices with a CNC system, spindle encoder. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Part programming of a CNC lathe: Process planning, tooling, preset and qualified tools, typical tools for turning and machining centers. Axes definition, machine and work piece datum, turret datum, absolute and incremental programming, tape codes , ISO and EIA codes, G and M functions, tool offset information, soft jaws, tool nose radius compensation, long turning cycle, facing cycle, constant cutting velocity, threading cycle, peck drilling cycle, part programming examples. | | | | 10 |
| **IV** | Manual part programming of a machining centre: Co-ordinate systems, cutter diameter compensation, fixed cycles, drilling cycle, tapping cycle, boring cycle, fine boring cycle, back boring cycle, area clearance programs, macros, parametric programming, part programming examples. CAD/CAM based NC programming, features of typical CAM packages. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**   1. James Madison, “CNC machining hand book”, Industrial Press Inc., 1996 2. Steve Krar, Arthur Gill, “CNC technology and programming”, McGraw-Hill, 1990 3. Berry Leathan - Jones, “Introduction to computer numerical control”, Pitman, London, 1987 4. Hans B. Kief, T. Fredericx Waters, “Computer numerical control”, MacMillan / McGraw-Hill, 1992 5. Bernard Hodgers, “CNC part programming work book”, City and Guids / Macmillan, 1994. 6. David Gribbs, “An introduction to CNC machining”, Cassell, 1987 7. Sadasivan, T. A. and Sarathy, D., “Cutting tools for productive machining”, Widia (India) Ltd., 1999 8. Radhakrishnan, P., “Computer numerical control machines”, New Central Book Agency, 1992   Peter Smid, “CNC programming hand book”, Industrial Press Inc., 2000 | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6036** | | **MICRO AND NANO MANUFATURING** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To discuss the various manufacturing processes of MEMS and semiconductor devices. 2. To study size-effects and material/interface behaviour at the micro-/nano scale. 3. To study the structure, properties and applications of carbon based nanostructures.   **COURSE OUTCOMES**   1. A good understanding of the fundamentals associated with manufacturing at the micro and nano scale. 2. In depth knowledge of micro and nano structures and their processing methods and techniques. | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Characterizing etching processes in bulk micromachining - microfabrication of MEMS and semiconductor devices -basics of microfabrication, integrated circuit fabrication etc - crystallography and its effects, silicon as substrate and structural material, stress and strain, - crystal plane effects on etching, wet etching process, reaction phenomena, anisotropic etching, isotropic etch curves, masking for anisotropic etchants, etching control, fusion bonding of silicon on an insulator, deep reactive ion etching, fabrication of a cantilever probe, manufacture, microprocessors etc and applications- problems with etching in bulk micromachining. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Photolithography: Principle of the soft lithography and applications -principle of microcontact printing and applications - characterizing the surface micromachining process, isolation layer, sacrificial layer, structural material, selective etching – properties, stress, stress measurement, stiction - wafer bonding: anodic and fusion, bonding. Micro and nanotechnology: Applications for space micropropulsion - subsystems and devices for miniaturised spacecrafts micropropulsion: microbolomete, micro FEEP, integrated cold-gas microthruster, microturbogas, pyrotechnic actuator and microvalve etc - propulsion systems: solid propellant, ADCS etc. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Carbon nanotube production and applications: Basis of nanotechnology - structure and properties of carbon nanotubes- production of carbon nanotube: chemical vapour deposition, arc discharge, laser ablation, mechanisms of growth, purification of carbon nanotube – applications: electrical transport of carbon nanotubes for FET, Computers, nanodevices for biomedical, X-ray equipment, nanomechanic actuator and artificial muscles, fuel cells, membrane electrode assembly, mechanical and electrical reinforcement of bipolar plates, hydrogen storage etc. | | | | 10 |
| **IV** | Carbon based nanostructures: - Structure of carbon nanotubes, Y-shaped, double helical, bamboo, hierarchical morphology - structure of fullerenes - structure of carbon nanoballsstructure of carbon nanofibers - porous carbon - properties of carbon nanostructures – synthesis - 15 potential applications of nanostructures - composite materials - nanotechnology for fuel cell applications: nanoparticles in heterogeneous catalysis, O2 electroreduction reaction on carbonsupported Pt catalysts, carbon nanotubes as catalyst supports. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**   1. Nitaigour Premchand Mahalik, “Micromanufacturing and nanotechnology”, Springer. 2. M. Kahrizi, “Micromachining techniquess for fabrication of micro, nano structures”. 3. Mark J. Jackson, “Micro and nanomanufacturing”, Springer 4. Jeremy Ramsden, “Micro & nano technologies”, Elsevier. | | | | | |
| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6066** | | **SEMINAR I** | 0-0-2-2 | 2015 | |
| Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the second semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student’s paper, presentation and his/her participation in the seminar. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6088** | | **MINI PROJECT** | 0-0-4-2 | 2015 | |
| The mini project is designed to develop practical ability and knowledge about practical tools/techniques in order to solve the actual problems related to the industry, academic institutions or similar area. Students can take up any application level/system level project pertaining to a relevant domain. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. For external projects, students should obtain prior permission after submitting the details to the guide and synopsis of the work. The project guide should have a minimum qualification of ME/M.Tech in relevant field of work. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted by the student for final evaluation. Publishing the work in Conference Proceedings/ Journals with National/ International status with the consent of the guide will carry an additional weightage in the review process. | | | | | |
| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 6092** | | **INDUSTRIAL ENGINEERING AND COMPUTATIONAL LABORATORY** | 0-0-3-2 | 2015 | |
| 1. Experiments on Method Study 2. Experiments on Time Study 3. Vocational Guidance Tests 4. Muscle Dynamometer Tests 5. Eye-Hand Coordination Experiments 6. Depth Perception Tests 7. Visual Acuity Tests 8. Construction of Control Charts for Quality Planning and Analysis 9. Solving linear programming problems using softwares. 10. Generation and testing of random numbers and simulation of discrete systems. 11. DoE Plan; Analysis of mean, ANOVA for experimental data. 12. Application of software like Mat Lab, SPSS, ARENA, WITNESS etc for the modeling, simulation and analysis of decision problems in the following areas:     * 1. Quality management       2. Production planning and control       3. Inventory and supply chain management       4. Reliability analysis       5. Manufacturing system design       6. Performance of manufacturing systems       7. Facilities planning 13. Experiments in CNC machines | | | | | |
| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 7041** | | **PRODUCTION SCHEDULING** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce theory and algorithms for scheduling several tasks over time 2. To provide an understanding of measures of performance, single machine scheduling and flowshop scheduling 3. To study line balancing algorithms and project scheduling techniques   **COURSE OUTCOMES**  Students should be able to:   1. Apply the concepts of sequencing and scheduling on the factory floor 2. Have knowledge about the fundamental research topics in the field of production scheduling | | | | | |
| MODULE | COURSE CONTENT (36 hrs) | | | | HRS |
| **I** | Introduction to scheduling – objectives in scheduling - processing characteristics and constraints – performance measures. Single machine scheduling – sequencing theorems - SPT rule to minimize mean flow time, EDD rule to maximum lateness – branch and bound technique to minimize mean tardiness – assignment model. Parallel processors – minimization of makespan, mean weighted flowtime - McNaughton’s algorithm, heuristic procedures. | | | | 9 |
| **INTERNAL TEST 1 (Module 1)** | | | | | |
| **II** | Flow shop scheduling – Extension of Johnsons’s rule for 3 machine problem – branch and bound technique – Palmer’s heuristic. Job shop scheduling – introduction to dispatching rules – SPT, FCFS, MWKR, MOPNR, LWKR, RANDOM – two jobs and m machines scheduling - Giffler and Thomson algorithm. | | | | 9 |
| **INTERNAL TEST 2 (Module 2)** | | | | | |
| **III** | Mass production management - basic idea of assembly line balancing - optimization of number of stations with given production rate - minimization of cycle time with fixed number of stations.  Line balancing algorithms – largest candidate rule, Kilbridge and Wester, rank positional weight method, COMSOAL. | | | | 10 |
| **IV** | Project scheduling – project network – AOA and AON - Gantt chart – critical path scheduling – probabilistic method for project scheduling – deployment of resources – activity time/cost trade-off analysis, resource leveling and resource allocation. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**   1. R. Paneerselvam, “Production and operations management”, Prentice-Hall, New Delhi, 2005 2. Roberta S. Russell and Bernard W. Taylor III, “Operations management”, Pearson Education, Delhi, 2003 3. Kenneth R. Baker, “Introduction to sequencing and scheduling”, John Wiley and Sons, 1974 4. Michael Pinedoo, “Scheduling: theory, algorithms and systems”, Prentice Hall, New Delhi, 1995. 5. Wild, R., “Mass production management”, John Wiley and Sons, New York. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 7043** | | **ALGORITHMS FOR DECISION MAKING** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce fundamental techniques for developing algorithms used for decision making 2. To discuss the basic concepts, use and applications of genetic algorithm 3. To introduce multi objective optimization algorithms 4. To discuss benchmarking of algorithms and performance metrics   **COURSE OUTCOMES**   1. Students should have a basic understanding of the use of various algorithms for decision making 2. Students should be able to develop algorithms for solving optimization problems in research areas. | | | | | |
| MODULE |  | | | | HRS |
| **I** | Introduction to algorithms: Scope of algorithms – steps of development of algorithms - components of algorithm. Types of problem – polynomial problem and combinatorial problem. Types of solution procedures – complete enumeration method – branch and bound method – heuristics - applications in travelling salesman problem. | | | | 9 |
| **II** | Understanding of single objective evolutionary algorithms: Genetic algorithm - basic concepts – binary genetic algorithm - encoding, selection, crossover, mutation - real-parameter genetic algorithm - constraint handling in genetic algorithms - application of GA in travelling salesman problem. | | | | 9 |
| **III** | Multi-objective optimization: Basic concepts - difference with single objective optimization – approaches to multi-objective optimization – Pareto optimality – non-dominated sorting. Non-dominated sorting genetic algorithm (NSGA) – elitist non-dominated sorting genetic algorithm (NSGA-II). | | | | 10 |
| **IV** | Benchmarking of algorithms: need – comparison of algorithm using optimal solution - comparison of algorithm in terms of performance measure of another algorithm.  Illustrative representation of non-dominated solutions: scatter-plot method – value path method – bar chart method – star coordinate method – visual method. Performance metrics in multi-objective algorithms: metrics evaluating closeness to the Pareto-optimal front – metrics evaluating diversity among non-dominated solutions – metrics evaluating closeness and diversity. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**   1. Kalyanmoy Deb, “Multi-objective optimization using evolutionary algorithms”, John Wiley & Sons (Asia) Pte. Ltd., Singapore, 2005. 2. R. Pannerselvam, “Design and analysis of algorithms”, Prentice-Hall of India, New Delhi, 2007. 3. Reeves C., “Modern heuristic techniques for combinatorial problems”, Orient Longman 4. Gen and Cheng, “Genetic algorithms and engineering design”, John Wiley 5. Goldberg, “Genetic algorithms in search, optimization and machine learning”, Addison Wesley | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 7045** | | **STATISTICAL METHODS FOR ENGINEERING RESEARCH** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce the concepts of experimental design and applications 2. To discuss reliability assessment and reliability testing 3. To discuss the various models in multivariate analysis   **COURSE OUTCOMES**   1. Students should understand the use of statistical methods necessary to conduct statistical analyses for research. 2. Students should possess the skills to apply statistical models to a wide variety of real life problems 3. Students should be able to provide correct interpretations from a set of analyses and include any limitations. | | | | | |
| MODULE |  | | | | HRS |
| **I** | Design of experiments: Analysis of variance - completely randomized design **- randomized complete block design - latin square design – Ducan’s multiple range test.** Factorial design: 2n factorial design – 22 and 23 factorial design - Yates’ algorithm for 2n factorial experiment. | | | | 9 |
| **II** | Reliability assessment: Definition and importance of reliability - pattern of failures - factor of safety and reliability - reliability management. Time dependent reliability of components and systems - failure rate time curve - series and parallel systems - (k, n) systems, complex systems. Strength based reliability and inference theory. | | | | 9 |
| **III** | Reliability testing: Objectives of reliability test - details of reliability tests - analysis of failure time - accelerated life testing - sequential life testing - statistical inference and parameter estimation - confidence intervals - plotting of reliability data. | | | | 10 |
| **IV** | Multivariate methods: Discriminant analysis – two-group and multiple discriminant analysis. Factor analysis – terminologies – methods of factor analysis. Cluster analysis – concepts – similarity measures – clustering techniques – hierarchical clustering algorithm – rank order clustering algorithm. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**   1. Panneerselvam, R., “Research methodology”, Prentice Hall of India, New Delhi, 2011 2. Rao, S. S. “Reliability-based design”, McGraw Hill, 1992. 3. Montgomery, D. C., “Design and analysis of experiments”, John Wiley and Sons, New York, 2008. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 7051** | | **Sensors for Industrial Applications** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To discuss the physical principles applied in various sensors like thermal, mechanical, electrical and optical sensors. 2. To study the applications of sensors for condition monitoring and automatic identification techniques in shop floor.   **COURSE OUTCOMES**   1. Understand the principles of operation of various sensors. 2. Understand the use of sensors for various industrial applications. | | | | | |
| MODULE |  | | | | HRS |
| **I** | Introduction – sensor fundamentals – characteristics – operation principles of different sensors: electrical, optical, acoustic, pneumatic, magnetic, temperature, electro optical and vision sensors. | | | | 9 |
| **II** | Condition monitoring of manufacturing systems – principles – techniques – selection of sensors – sensors for monitoring force, pressure, humidity, radiation, temperature, vibration and noise. Sensor materials and technologies. | | | | 9 |
| **III** | Acoustic emission – principles and applications – concepts of pattern recognition. Sensor network to detect machinery faults – network architecture in manufacturing – fiber optic networks. Laser sensors. | | | | 10 |
| **IV** | Automatic identification techniques for shop floor control – bar code scanners – radio frequency identification systems – optical character recognition. Smart / intelligent sensors – integrated sensors. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  Sabrie Soloman, Sensors: hand book, McGraw Hill  Jorg Scholz (Editor), Thermal sensors: Vol. IV, sensors: a comprehensive survey, John Wiley & Sons  H. H. Bau (Editor), Mechanical sensors: Vol. VII, sensors: a comprehensive survey, John Wiley & Sons  Ljubisa Ristia (Editor), Sensor technology and devices, Artech House Publishers. | | | | | |

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| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 7053** | | **MANAGEMENT INFORMATION SYSTEMS** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To discuss the basic concepts and design of information systems. 2. To study the evolution of information systems and differentiate between the various types of information systems. 3. To study the role of information technology in Management Information Systems.   **COURSE OUTCOMES**   1. Knowledge about the basic concepts of information systems. 2. Identify the impact information systems have on an organization. 3. Understand the role of computers and information technology on the way business is conducted. | | | | | |
| MODULE |  | | | | HRS |
| **I** | Introduction: Meaning and definition – system approach – role of MIS to face increased complexity of business and management – system view of business – MIS organization within the company.  Conceptual information system design: Defining the problems – setting system objectives – establishing system constraints – determining information needs – determining information sources – developing alternate conceptual design and selecting one – documenting the conceptual design – preparing the conceptual design report. | | | | 9 |
| **II** | Detailed information system design: Informing and involving the organization – project management of MIS detailed design – identifying dominant and trade-off criteria – defining the subsystems – sketching the detailed operating subsystems and information flows – determine the degree of automation – informing and involving the organization again – inputs, outputs and processing – early system testing – propose an organization to operate the system – documentation – revisiting the manager-user. | | | | 9 |
| **III** | Evolution of information systems: Basic information systems – financial information systems – production / operations systems – marketing information systems – personnel information systems. Information system softwares – selection – complexity and errors.  Information systems and decision making: Decision making and MIS – programmed and non programmed decision – MIS for making programmed decisions – decision-assisting information systems – components of decision support systems. | | | | 10 |
| **IV** | Information technology and MIS: Comparison of manual and computer based information systems – conversation of manual to computer based systems – types of computer based applications in MIS – application of multimedia, internet, intranet and extranet technologies in MIS. E-business: Introduction – models – security. | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**   1. Henry C. Lucas Jr., The analysis, design and implementation of information systems, 4th Edition, McGraw Hill Company, New York, 1992. 2. Burch J. E., Strater F. R & Grudnikski G., Information systems: theory and practice, John Wiley and Sons, New York, 1987. 3. Murdick R. G., Ross J. E. & Claggett J. R., Information systems for modern management, 3rd Edition, Prentice Hall of India Private Ltd., India, 1992. 4. James A. O’Brien, Management information systems: a managerial end user perspective, Galgotia Publications, 1997. | | | | | |
| COURSE CODE | | COURSE NAME | L-T-P-C | YEAR | |
| **05ME 7055** | | **FINANCIAL ENGINEERING AND ECONOMICS** | 3-0-0-3 | 2015 | |
| **COURSE OBJECTIVES**   1. To introduce financial management concepts including capital budgeting and financing 2. To provide an understanding of basic theories of economics   **COURSE OUTCOMES**  Students should be able to:   1. Understand the financial decisions of a firm, importance of capital budgeting and sources of capital 2. Apply the concepts of financial management to contemporary financial events 3. Understand the application of demand elasticity and utility analysis 4. Understand various market structures with regard to competition, monopoly and oligopoly | | | | | |
| MODULE |  | | | | HRS |
| **I** | Introduction: Objectives of financial management - financial decisions in a firm - agency problem - financial management in India  Time value of money - compounding and discounting techniques  Capital budgeting: Capital budgeting process - investment criteria - NPV, IRR, ARR, benefit cost ratio, payback period, accounting rate of return  Working capital management: Factors affecting working capital - management of cash and marketable securities  Receivables management | | | | 9 |
| **II** | Sources of long term finance - equity capital - preference capital - debenture capital - term loans - retained earnings - depreciation  Financial instruments  Financial institutions  Capital structure: Factors affecting - capital structure theories - net income - net operating income - MM approach - traditional approach  Dividends – forms - dividend policy – determinants - MM hypothesis - Walters model -Gordons model | | | | 9 |
| **III** | Demand theory: Utility analysis - indifference curve technique - consumers equilibrium -income effect - substitution effect - price effect  Elasticity of demand – price – income – cross - measurement of elasticity  Consumer surplus | | | | 10 |
| **IV** | Theory of costs: Opportunity cost - implicit and explicit cost - short run total, average and marginal costs - cost curves - long run average cost curve  Marginal and average revenue  Market structures - perfect competition – monopoly - monopolistic competition - price and output determination – oligopoly - kinked demand curve - price leadership - collusive oligopoly | | | | 8 |
| **END SEMESTER EXAM (All Modules)** | | | | | |
| **REFERENCES:**  1. Khan and Jain, “Financial management”, Tata McGraw Hill  2. Prasanna Chandra, “Financial management”, Tata McGraw Hill  3. James C. Van Horne, “Financial management and policy”, Prentice Hall of India  4. Brealy and Onyers, “Principles of corporate finance”, McGraw Hill  5. Paul Samuelson, “Economics”, Tata McGraw Hill  6. Ruddar Datt, “Indian economy”, S. Chand and Company Ltd.  7. K. K. Dewett, “Modern economic theory”, S. Chand and Company Ltd. | | | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05ME 7067** | **SEMINAR II** | 0-0-2-2 | 2015 |
| Each student shall prepare a seminar paper on any topic of interest related to the core/elective courses being undergone in the third semester of the M. Tech. programme. He/she shall get the paper approved by the Programme Coordinator/Faculty Members in the concerned area of specialization and shall present it in the class in the presence of Faculty in-charge of seminar class. Every student shall participate in the seminar. Grade will be awarded on the basis of the student’s paper, presentation and his/her participation in the seminar. | | | |

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| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05ME 7087** | **PROJECT (PHASE I)** | 0-0-8-6 | 2015 |
| The project (phase I) shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed.  In phase I of the project it is expected that the student should decide a topic of thesis, which is useful in the field or practical life. It is expected that students should refer national and international journals, proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work/experimentation carried out on the thesis topic.  Student should submit phase I project report in two copies covering the content discussed above and highlighting the features of work to be carried out in part I of the project. Student should follow standard practice of thesis writing.  The candidate will deliver a talk on the topic and the assessment will be made on the basic of the term work and talks there on by a panel of internal examiners one of which will be the internal guide. These examiners should give suggestions in writing to the student to be incorporated in project work phase II. | | | |
| COURSE CODE | COURSE NAME | L-T-P-C | YEAR |
| **05ME 7088** | **PROJECT (PHASE 2)** | 0-0-21-12 | 2015 |
| In the fourth semester the student has continue project work and after successfully finishing the work, he / she has to submit a detailed bounded thesis report. The work carried out should lead to a publication in a National / International Journal or Conference. They should have submitted the paper before M. Tech. evaluation and specific weightage should be given to accepted papers in reputed journals or conferences. | | | |