I SEMESTER

21PP01 ADVANCED OPERATIONS RESEARCH  

LINEAR PROGRAMMING: Formulation of linear programming – simplex algorithm, phase I and phase II of simplex method - simplex multipliers - revised simplex method - dual and primal, dual simplex method. (11+4)

INTEGER PROGRAMMING: Gomory cutting plane methods for all integers and mixed integer programming problems - branch and bound method (Land - Doig and Dakin algorithms). (11+4)


REFERENCES:

Total L: 45 + T: 15 = 60

21PP02 CNC AND AUTOMATION

CNC CONSTRUCTION: Types - construction of CNC machines - structures, guideways, ball screws, spindle, turret, ATC, APC - control system - feedback devices - spindle and feed drives - servo motors - types of interpolators - maintenance - testing of CNC machines. (11)

CNC PROGRAMMING: Selection of machines, tools - work holding - job requirements - raw material, tolerances, surface finish, process plan, production costs, machine hour rate - G-codes - M-codes - canned cycles - turning centre programming - machining centre programming - industrial component programming, casting and die casting parts, bar feeder components. (11)

AUTOMATED FLOW LINES: Introduction to CIM - components of CIM - process design for CIM - automated flow lines - methods of work transport, automated flow lines with and without storage buffers - automated guided vehicle system - components of AGVs, control system, routing, design features - AS/RS - components, design of an AS/RS - automated inspection - online and offline inspection. (12)

AUTOMATED ASSEMBLY: Historical perspective - why and when automated assembly - parts of automated assembly system - part feeding and orienting, feed track, escapement and placement devices - robots in assembly - analysis of assembly systems with synchronous transfer and free transfer - economics of automated assembly. (11)

REFERENCES:

Total L: 45

21PP03 FUTURISTIC MATERIALS AND THEIR PROCESSING


ENERGY MATERIALS AND SYNTHESIS: Need for high performance energy materials - carbon nanostructure based energy conversion and storage materials - nanomaterials for solar cell applications - next generation energy storage materials – Li and Ni based batteries, fuel cells - introduction to synthesis of nanostructures - top down and bottom up approaches - physical methods - high energy ball milling, physical vapour deposition (PVD), laser ablation, sputter deposition methods (Qualitative), chemical vapour deposition (CVD) - chemical methods - sol gel technique, hydrothermal synthesis. (11)

HEALTHCARE MATERIALS AND MANUFACTURE: Introduction to healthcare materials - diagnosis and therapeutic materials - futuristic implants and prosthetics - polymer, ceramic and metallic based - laser machining of bio materials - micromachining and micro moulding - additively manufactured biomaterials. (10)

REFERENCES:

TOTAL L: 45

21PP04 DESIGN FOR MANUFACTURE AND ASSEMBLY

TOLERANCE STACKUP ANALYSIS: Introduction to DFM - DFA - standardization - DFA index - cumulative effect of tolerances - worst case method, root sum square method, dimensions following truncated normal distributions, tolerance synthesis, nonlinear tolerance analysis, tolerance cost relationships - process capability - interchangeable part manufacture and selective assembly - deciding the number of groups - control of axial play - introducing secondary machining operations - laminated shims. (13)

GEOMETRIC DIMENSIONING AND TOLERANCING: Introduction to Model Based Definition - ISO 16792 and ASME Y14.41 standards – standards for geometric tolerance ASME Y 14.5 and ISO 1101 - examples for application of geometric tolerances - True Position Theory - comparison between co-ordinate and convention method of feature location - tolerancing and true position tolerancing, virtual size concept, floating and fixed fasteners, projected tolerance zone, zero true position tolerance, functional gauges, paper layout gauging, compound assembly, examples - datums - datum feature, simulate datum feature, datum targets, grouped datum system with spigot and recess, pin and hole, computation of translational and rotational accuracy, geometric analysis and applications. (12)

FORM DESIGN OF CASTINGS AND WELDMENTS: Redesign of castings - based on parting line considerations, minimizing core requirements - redesigning cast members using weldments - form design aspects of sheet metal components, component design - machining considerations - redesign for manufacture. (10)

TOLERANCE CHARTING: Operation sequence for typical shaft type of components - preparation of process drawings for different operations, tolerance worksheets - centrality analysis - examples design features to facilitate machining, datum features - functional and manufacturing. (10)

TUTORIALS:
1. Tolerances stack up analysis of a 2D assembly.
2. Problems on Model I and Model II type selective assembly.
3. Redesign of casting.
4. Redesign for machining
5. Tolerance charting.

REFERENCES:

TOTAL L: 45 + T: 15 = 60
21PP05 ADVANCED METROLOGY

CALIBRATION AND EVALUATION OF UNCERTAINTY: Measurement principle, calibration, standards, environmental conditions required, traceability of measurement, calibration procedure for vernier calliper, micrometer and dial gauge, evaluation of uncertainty of measurement, repeatability and reproducibility (R&R) analysis.

FORM MEASUREMENT AND COORDINATE METROLOGY: Computational metrology-types of filter used in surface roughness measuring instruments and form measuring instruments - geometric data fitting - least-square best-fit line, plane and circle, measurement of straightness, flatness and circularity errors - coordinate measuring machine - need, types of CMM, modes of operation, types of probe, probe calibration, dimensional measurement in CMM - computer-aided inspection planning (CAIP).

NON-CONTACT MEASUREMENT SYSTEM: Computed tomography - machine vision system - need, applications, algorithms for machine vision-based inspection - laser metrology - interferometry, measurement of displacement, flatness, parallelism and gauge block calibration - micro and nano metrology - atomic force microscopy, scanning electron microscopy, white light interferometry.

MODEL BASED DEFINITION: Need - digital product definition data - creation of model-based definition model - generation of probe path planning for CMM.

TUTORIALS:
1. Calibration of basic measuring instruments and estimation of uncertainty.
2. Evaluation of repeatability and reproducibility (R&R) of measuring instruments.
3. Straightness measurement using autocollimator.
4. Displacement measurement using Michelson interferometer.
5. Object recognition and dimensional metrology using machine vision system.
6. Form measurement using coordinate measuring machine (CMM).

REFERENCES:

21PP61 RESEARCH METHODOLOGY AND IPR

dide Automobile Engineering 21AE06

21PP72 AUDIT COURSE - I

dide Automobile Engineering 21AE72

21PP51 OBJECT COMPUTING AND DATA STRUCTURES LABORATORY

Object Computing (Using Python)
1. Implementation of Number data types and operations on them.
2. Creation and Implementation of string objects and string methods.
3. Creation and manipulation of list and tuple data types.
4. Implementation of set and dictionary data types.
5. Implementation of simple functions, lambda functions and recursive functions and modules.
6. Implementation of object oriented concepts – classes, objects, methods
7. Implementation of inheritance and polymorphism

Data Structures (Using Python)
1. Implementation of sorting algorithms- Bubble, insertion and selection sort
2. Implementation of Stack.
3. Implementation of queue.
4. Implementation of singly linked list and doubly linked list

REFERENCES:

21PP52 OBJECT COMPUTING AND DATA STRUCTURES LABORATORY

Object Computing (Using Python)
1. Implementation of Number data types and operations on them.
2. Creation and Implementation of string objects and string methods.
3. Creation and manipulation of list and tuple data types.
4. Implementation of set and dictionary data types.
5. Implementation of simple functions, lambda functions and recursive functions and modules.
6. Implementation of object oriented concepts – classes, objects, methods
7. Implementation of inheritance and polymorphism

Data Structures (Using Python)
1. Implementation of sorting algorithms- Bubble, insertion and selection sort
2. Implementation of Stack.
3. Implementation of queue.
4. Implementation of singly linked list and doubly linked list

REFERENCES:

21PP52 OBJECT COMPUTING AND DATA STRUCTURES LABORATORY

Object Computing (Using Python)
1. Implementation of Number data types and operations on them.
2. Creation and Implementation of string objects and string methods.
3. Creation and manipulation of list and tuple data types.
4. Implementation of set and dictionary data types.
5. Implementation of simple functions, lambda functions and recursive functions and modules.
6. Implementation of object oriented concepts – classes, objects, methods
7. Implementation of inheritance and polymorphism

Data Structures (Using Python)
1. Implementation of sorting algorithms- Bubble, insertion and selection sort
2. Implementation of Stack.
3. Implementation of queue.
4. Implementation of singly linked list and doubly linked list

REFERENCES:
In this course, students will be provided with an orientation programme on advanced equipment used for research in manufacturing for a duration of 20 hours. After this orientation, each student is expected to formulate, design and conduct an experiment in an area of interest, derived from the orientation programme, under the guidance of a faculty. Details like background, problem definition, state of technology/knowledge, in a selected area of interest, in the form of literature review (referring a minimum of five latest peer reviewed journal papers), objectives, methodology, equipment that can be used (from the orientation programme), results from the experiments, their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. This work is evaluated for the credit assigned. Expected hours needed for this work is 40 hours.

Topics for orientation programme
1. Experimental and theoretical investigations on the effect of process parameters in deep drawn components.
2. Investigating tensile strength of plastic molded specimen in plastic injection moulding machine
3. Improving the mechanical properties of prototypes prepared using 3D printing and subtractive rapid prototyping processes.
4. Analyzing and optimizing the joint quality of ultrasonically welded components.
5. Study on effect of machining parameters in electro discharge machining.
6. Optimizing the cutting parameters in a machine tool using dynamometer and accelerometer.
7. Experimental investigations on geometrical and surface qualities of machined parts in CNC Lathe.
8. Experimental investigations on geometrical and surface qualities of machined parts in CNC VMC.
9. Characterization of mechanical and tribological properties for a material.
10. Investigating surface roughness parameters in machining, grinding and super finishing processes.

Total: P: 60

II SEMESTER

21PP06 ENGINEERING ECONOMICS

ECONOMIC EQUIVALENCE, EVALUATION OF BUSINESS AND ENGINEERING ASSETS:
Present economic policy, liberalization, privatization, and globalization, the scope for industrial growth, Cash-flow diagram, simple interest, compound interest, single payments, uniform series payments, interest factors and interest tables, nominal and effective interest rates, continuous compounding, and uniform continuous payments, linear-gradient series, geometric gradient series, mixed payment series. Methods for evaluation of alternatives: Present worth comparison - equal, unequal lived assets, study period, assets with infinite life, capitalized cost comparison. Equivalent uniform annual cost comparison, Rate of return comparison.

MICROECONOMICS: Scope of microeconomics, tools, themes of microeconomics, uses of microeconomics; economic decision making on production; technology and production - production technologies, production with one variable input, production with two variable inputs, returns to scale, productivity differences and technological change; profit maximization - profit-maximizing quantities and prices, marginal revenue, marginal cost, and profit maximization, supply decisions by price-taking firms, short-run versus long-run supply by price-taking firms, producer surplus, supply by multi product price-taking firms.


PROJECT FEASIBILITY ANALYSIS: Market feasibility: Types of market, identification of investment opportunities, market and demand analysis, secondary sources of information. Technical feasibility: Product design, the concept of concurrent engineering; plant design, make vs buy decisions; Financial feasibility: Means of financing, financial institutions, all India, state-level; Profitability: cash flows of a project, financial leverage of a business. Tax factors in investment analysis.

TUTORIALS
1. 'Cash flow diagram modelling' of a given case.
2. Computation of equivalent cash flows using compound interest factors.
3. Tangible evaluation of alternatives.
4. Cost volume profit analysis
5. Accounting manufacturing expenses and preparation of cost sheet of a product.

Total L: 45 + T: 15 = 60

REFERENCES:
21PP07 COMPUTER AIDED MODELING AND ANALYSIS

3 1 0 4

PARAMETRIC REPRESENTATION OF CURVES AND SURFACES: Introduction to parametric curves - representation of entities, DDA algorithms - transformations, translation, scaling, rotation, reflection, shear - representation of analytic and synthetic curves - interpolation and approximation of curves - representation of analytic and synthetic surfaces, Class A surfaces. (11)

GEOMETRIC MODELING: Fundamentals of solid modelling, properties, set theory, set membership - solid modelling techniques, boundary representation, constructive solid geometry - introduction to features - role of features in design and manufacturing features - features, attributes, types, properties - feature creation techniques - recognizing manufacturing features. (11)

FINITE ELEMENT ANALYSIS OF LINEAR PROBLEMS: Discretization of the domain - interpolation models - higher order and isoparametric formulation of elements - derivation of element matrices and vectors - assembly of element matrices and vectors and derivation of system equations - solving time dependent problems. (11)

FEA IN MANUFACTURING: Material models - contact elements - modeling thermo mechanical problems - Goldak double ellipsoid heat source model - analysis of sheet metal bending - temperature analysis in cooling of casting - analysis of distortion in welding. (12)

Total L: 45 + T: 15 = 60

REFERENCES:

21PP82 AUDIT COURSE - I
vide Automobile Engineering 21AE82

21PP53 COMPUTER AIDED MODELING AND ANALYSIS LABORATORY

0 0 4 2

In this course, students will be provided with an orientation programme on the following software for a duration of 20 hours. After this orientation, each student is expected to formulate and complete an activity of interest which has to be derived from the orientation programme under the guidance of a faculty. The details like background, problem definition, state of technology/knowledge in that area by a good literature review (5 latest papers), objectives, methodology, equipment that can be used (from the orientation programme), results from the experiments and their interpretation with respect to the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. This work is evaluated for the credit assigned. Expected hours needed for this work is 40 hours.

Topics for Orientation Programme
1. Generation of analytical curves using a programming tool.
2. Exercise on Geometric transformations using a programming tool.
3. Constraint based modeling using CAD software
4. Exercise on assembly of components using CAD software
5. Static analysis of a component in CAE.
6. Transient analysis in CAE.
7. Harmonic analysis of a component in CAE.
8. Exercise on Sheet metal forming simulation
9. Exercise on casting simulation
10. Exercise on Welding problem

Total P: 60
In this course, students will be provided with an orientation programme on the following equipment/software for 20 hours. After this orientation, each student is expected to formulate and complete an activity of interest which has to be derived from the orientation programme under the guidance of a faculty. The details like background, problem definition, state of technology/knowledge in that area by a good literature review (5 latest papers), objectives, methodology, equipment that can be used (from the orientation programme), results from the experiments and their interpretation concerning the assumptions/background and a formal conclusion are expected in the report which is to be submitted at the end of the semester. This work is evaluated for the credit assigned. Expected hours needed for this work is 40 hours.

Topics for the orientation programme
1. Simulation of the pneumatic sequential circuit along with fringe conditions
2. Simulation of the electro-pneumatic sequential circuit
3. Simulation of PLC based sequential circuit
4. Simulation of hydraulic circuits using software
5. Integration of a modular manufacturing system using DIY kits
6. Energy monitoring of hydraulic press and injection moulding machine using IIoT
7. IIoT based integrated system for smart water dispenser
8. Performance monitoring of wind turbine using IIoT
9. Performance monitoring of CNC machine using IIoT
10. Performance monitoring of a modular manufacturing system using IIoT

Total P: 60

21PP63 INDUSTRIAL VISIT AND TECHNICAL SEMINAR
vide Automobile Engineering 21AE63

III SEMESTER

21PP71 PROJECT WORK I
vide Automobile Engineering 21AE71

IV SEMESTER

21PP81 PROJECT WORK II
vide Automobile Engineering 21AE81

PROFESSIONAL ELECTIVE THEORY COURSES (Four to be opted)

21PP21 ADDITIVE MANUFACTURING

INTRODUCTION AND DATA PROCESSING: Fundamentals of Additive Manufacturing (AM) - materials used in AM, fundamentals of energy dissipation, classifications of Additive Manufacturing systems, Information workflow in Additive Manufacturing, impact of AM on Product development, reverse engineering - digitization techniques, model reconstruction, data Processing for Additive Manufacturing, Additive Manufacturing data formats - STL Format, STL file problems, consequences of building a valid and Invalid tessellated model, STL file repair. (10)


ADDITIVE MANUFACTURING SYSTEMS: Principle, details of processes, process variables, types, products, materials, microstructures and mechanical properties of additive manufactured parts, advantages, applications and case studies: Solid, liquid, powder based and other additive manufacturing processes. (13)

LASER ASSISTED ADDITIVE MANUFACTURING: Fundamental relationship of working curve, intensity profile, profile of scan lines - single-scan line, multi-scan line and layer. Laser scanning in additive manufacturing and powder binding mechanism. Laser assisted additive manufacturing of low cost tools, porous materials and bimetallic components. Mechanical properties of additive manufactured structures. (10)

Total L: 45
REFERENCES:

21PP22 ADVANCED CASTING AND WELDING TECHNOLOGIES


CASTING METALLURGY AND DESIGN: Heat transfer between metal and mould - solidification of pure metals and alloys - shrinkage in cast metals - progressive and directional solidification - degasification of the melt - effect of normal elements and alloying elements in cast iron, steel, non-ferrous metals - design principles of gating, riser - design considerations in casting - casting defects - causes, remedies, inspection - specifications - BIS, BS, EN, ASTM standards.


REFERENCES:

Total L: 45

21PP23 DESIGN OF FLUID POWER SYSTEMS

COMPONENTS OF FLUID POWER SYSTEMS: Pneumatic and hydraulics - symbols of fluid power elements - pumps and compressors - types, selection - actuators - types, typical construction details - control valves - direction, flow, pressure, types, typical construction details, applications - logical elements - accumulators - intensifiers - selection of elements based on force, speed, travel and time - sizing of pipes - piping layout and accessories - maintenance and troubleshooting of fluid power circuits - circuit layout - presentation and labelling as per ISO standards.

FLUID POWER CIRCUITS: Typical industrial applications of fluid power systems - metal working, handling, clamping and other industrial applications - general approach for circuit design - travel step diagram, sequential circuit design, cascade method, step counter method, K.V. mapping for minimization of logic equation.

ELECTRICAL AND SERVO CONTROL SYSTEMS: Electrical control circuits - electro-pneumatics, ladder diagram - PLC - construction, types, operation, programming, PLC timers and counters - servo and proportional valves - types, operation, application, hydro-mechanical servo systems.

COMPOUND CIRCUIT DESIGN: Introduction to compound circuit design - fringe condition modules - emergency stop modules, cycle selection modules, start restriction module, typical industrial applications.

REFERENCES:

21PP24 DIGITAL MANUFACTURING

TECHNOLOGIES FOR DIGITAL MANUFACTURING: Need for digital manufacturing - informatics platform for designing and developing e-manufacturing systems, information sharing in digital manufacturing, collaborative process planning activities, adaptive setup planning for job shop operations, web based value streams.

CAD/CAM FOR RAPID MANUFACTURING: CAD for rapid manufacturing, CAD standards - reverse engineering process - reverse engineering hardware and software - computer aided engineering analysis - CNC tool path generation and simulation.

RAPID MANUFACTURING TECHNOLOGIES: Overview of rapid manufacturing - impact of rapid manufacturing on design for manufacture and design for assembly, liquid, powder and solid based rapid manufacturing processes, applications of rapid manufacturing in aerospace, space and automotive industries.

INTERNET OF THINGS (IoT): IoT data management requirements - architecture of IoT, technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things, industrial internet of things (IIoT), IoT based solution for just in time manufacturing, IoT for energy consumption modeling in machine tools, issues in implementing IoT.

REFERENCES:

Total L: 45

21PP25 FINITE ELEMENT APPLICATIONS IN MANUFACTURING

MATHEMATICAL MODELLING: Understanding manufacturing processes as an interaction of material - stress and strain energy - derivation of strain rate matrix - mathematical representation of manufacturing processes - metal casting, metal forming, machining, welding.


REFERENCES:

Total L: 45

21PP26 IMAGE PROCESSING AND MACHINE VISION

DIGITAL IMAGES AND PREPROCESSING: Image formation - binary, gray and color images - steps in digital image processing - human visual system - image sampling and quantization - relationships between pixels - image enhancement - gray level transformations, histogram processing, image sharpening and smoothing, spatial and frequency domain filters - color image processing, color models, Pseudocolor Image processing, color transformations.

IMAGE RESTORATION AND SEGMENTATION: Image restoration - noise models, noise reduction using spatial and
frequency domain filters - Image segmentation - edge and line detection, thresholding, region-based segmentation.  

**FEATURE EXTRACTION AND PATTERN RECOGNITION:** Image representation - topological attributes, geometrical attributes - spatial moments - deterministic models - k-nearest neighbors algorithm - template matching.  

**MACHINE VISION:** Image acquisition - types of image sensors and their principles - camera calibration - illumination techniques - thin lens model - building a machine vision system - selection of camera, lens and illumination - laser vision system.  

**TUTORIAL**
1. Dimensional measurement
2. Surface finish analysis
3. Defect identification
4. Face recognition
5. Tool wear measurement
6. Robot guidance

**REFERENCES:**

**ANTHROPOMETRY:** History of ergonomics - interdiscipliary nature - ergonomics for productivity - safety, health and comfort - need for anthropometry - body planes - body movement ranges - measuring procedures - measurement tools - anthropometric measurements - percentile calculation - ergonomic guidelines for design use - anthropometry in applications.  

**INDUSTRIAL DESIGN:** Manual lifting - revised NIOSH lifting equation - material handling devices - work posture - sitting, standing or sit-standing - horizontal work surface design - console design for standing operator - seat design - hand tool design - fitting the task - designing for the user - design guidelines for hand tools - design of VDT workstations - information display modalities - design of controls - coding of controls, compatibility.  

**RISK ASSESSMENT:** Physical methods - QEC, RULA, REBA, strain index, Borg rating - psycho-physiological methods - electromyography, heart rate, heart rate variability, energy expenditure - cognitive methods - focus groups, hierarchical task analysis, SHERPA - environmental methods - thermal conditions measurements, cold and heat stress indices, thermal comfort analysis.  

**ENVIRONMENTAL ERGONOMICS:** Illumination - measurement of light - concept of visibility - effects of lighting on performance - recommended levels of illumination - distribution of light - glare - noise - measurement of sound - noise and loss of hearing - analysis and reduction of noise - effect of noise on performance - noise exposure limits - handling noise problems - whole body vibration - attenuation - amplification and resonance - effects of vibration - limits for exposure to whole-body vibration.  

**REFERENCES:**

**IOT ARCHITECTURE:** Introduction to IoT - IoT vs industrial IoT (IIoT) - M2M architecture - IoT architecture, definitions and functional requirements - sensing - actuation - wireless sensor networks - future developments - possible architecture for the future IoT use cases.  

**BASICS OF COMMUNICATION AND NETWORKING PROTOCOLS:** Internet communication - IP addresses - MAC addresses - wifi - zigbee - low energy bluetooth - long range radio (LoRa) - low power wireless personal area networks (6LoWPAN) - transmission control protocol (TCP) and user datagram protocol (UDP) - message queuing telemetry transport (MQTT).
ELECTRONIC PROTOTYPING: Prototypes and production - open source versus closed source - prototyping embedded devices - embedded computing basics - prototyping IoT projects - industrial IoT case studies. (12)

IOT DATA ANALYTICS: Sensor - cloud - types of cloud - edge analytics and fog computing - sensor data aggregation - sensor data mining techniques - big data analytics - predictive analytics. (12)

REFERENCES:

1PP29 LEAN SIX-SIGMA

LEAN MANUFACTURING: Origin of lean manufacturing at Ford - Lean manufacturing from Toyota production system - wastes to be eliminated in the Lean manufacturing paradigm - tools and techniques applied to eliminate wastes - value stream mapping (VSM) - symbols - current state VSM and future state VSM. (11)

SIX SIGMA: Definition – DMAIC and DMADV deployment models - project reporting - Six Sigma teams - team membership - stages in group development - member roles and responsibilities. (11)

LEAN SIX SIGMA THROUGH DEFINE, MEASURE AND ANALYZE PHASES: Project charter-project decomposition - Pareto analysis - critical to quality metrics - Kaizen-SIPOC - analyzing the source of variation-cause and effect diagram – correlation - design of experiments. (11)

LEAN SIX SIGMA THROUGH IMPROVE AND CONTROL PHASES: Improvement decisions - category importance weights- fault tree analysis – FMEA - visual management – SS-total productive maintenance - Poka Yoke-common errors - use of Poka Yoke - tools and techniques useful for control planning - process audits - selecting process control elements - Jidoka - theory and implementation. (12)

REFERENCES:

21PP30 LOGISTICS AND SUPPLY CHAIN MANAGEMENT

LOGISTICS: Definition of logistics and supply chain management - role of distribution in supply chain - distribution network design - factors influencing distribution network design - distribution networks in practice - network design in the supply chain - factors influencing the network design - framework for network design - models for facility location and capacity allocation - impact of uncertainty on network design. (10)

COORDINATED PRODUCT AND SUPPLY CHAIN DESIGN: Decision phases in a supply chain - objectives of SCM - examples of supply chains - supply chain drivers-supply chain integration - supply chain performance measures. General framework - design for logistics - standardization - push-pull boundary - supplier integration into new product development - keys to effective supplier integration - mass customization, meaning, mass customization and supply chain management. (10)


TECHNOLOGIES FOR SCM: Information Technology (IT) - infrastructure - interface devices - system architecture - electronic commerce - IT for supply chain excellence - service oriented architecture - radio frequency identification (RFID) - impact of internet. (10)

Total L: 45
REFERENCES:

21PP31 MECHANICS OF POLYMER MATRIX COMPOSITES

MANUFACTURE OF COMPOSITE COMPONENTS: Definitions and classification - matrix and reinforcement, their roles, principal types of fibre and matrix material - processing of PMC - layup and curing, open and closed mould processes, bag moulding, filament winding, pultrusion, pulforming, thermoforming, injection moulding, blow moulding - an overview of metal matrix composite processing and ceramic matrix composite processing.

MICRO MECHANICAL BEHAVIOUR OF A LAMINA: Volume and mass fractions - evaluation of elastic moduli-strength of unidirectional lamina.

MACRO MECHANICAL BEHAVIOUR OF A LAMINA: Hooke’s law for different types of materials, engineering constants for orthotropic materials-stress strain relations for plane stress in an orthotropic materials and in a lamina of arbitrary orientation-strength of an orthotropic lamina- basic strength theories.


REFERENCES:

21PP32 MECHANICS OF ROBOT


JACOBIAN: Joint velocities - motion generation - singularity - static forces in the manipulator - transformations of velocities and static forces in Cartesian space.

DYNAMICS: Newton’s equation - Euler’s equation - closed-form dynamic equations - lagrangian formulation - manipulator dynamics in Cartesian space.

TRAJECTORY GENERATION: Joint space - Cartesian space - collision free path generation - path planning - mechanism design - manipulator mechanism - actuation schemes - stiffness and compliance - position and force sensing.

REFERENCES:

21PP33 MECHATRONICS SYSTEM

MECHATRONICS: Need and applications - elements of mechatronic systems - the role of mechatronics in automation - manufacturing and product development - importance of sensors in mechatronics - static and dynamic characteristics of sensors, errors and output impedance of sensors - transducers for measurement of displacement, strain, position, velocity,
noise, flow, pressure, temperature, humidity, vibration, liquid level - vision sensors - linear and rotary drives - types and selection criteria. (11)

MECHANICAL SYSTEMS AND DESIGN: Mechatronic approach - control program - adaptive control and distributed systems - design process - types of design, integrated product design - mechanisms - load conditions, design and flexibility - structures - load conditions, flexibility and environmental isolation - man-machine interface - industrial design and ergonomics - information transfer from machine to man and man to machine - safety. (12)

REAL-TIME INTERFACING AND DATA ACQUISITION: Introduction - elements of data acquisition and control - overview of I/O process - installation of I/O card and software - installation of application software - over framing - general configuration of single-channel and multichannel data acquisition system - digital filtering - data logging - data conversion - introduction to digital transmission systems - PC-based data acquisition system. (11)

MECHATRONICS SYSTEM INTEGRATION: Transducer calibration system for automotive applications - strain gauge weighing system - solenoid force - displacement calibration system - rotary optical encoder - inverted pendulum control - pick and place robot - pH control system - case studies on the design of mechatronic products - motion control using DC motor - AC motor and solenoids - car engine management - barcodes and QR codes. (11)

REFERENCES:

Total L: 45

21PP34 NON-TRADITIONAL MACHINING PROCESSES

MECHANICAL MACHINING PROCESSES: Abrasive jet machining (AJM)-Abrasive water jet machining(AWJM) - Abrasive flow machining(AF), principles, process variables, mechanism of material removal, process capabilities, applications and limitations - ultrasonic machining, mechanics of cutting, process parameters, grain growing model, grain hammering model, analysis, capabilities. (11)

THERMO-ELECTRIC PROCESSES: Electro discharge machining (EDM), principle, components and functions process parameters, electrical circuit, material removal rate, process characteristics and application - Wire EDM - characteristics and applications - Electron beam machining (EBM), elements and their functions, process parameters and applications - Laser beam machining (LBM), laser production, types, process characteristics and applications - Plasma arc machining (PAM), elements, plasma arc torches, parameters, process capabilities. (12)

CHEMICAL AND ELECTRO CHEMICAL MACHINING: Chemical machining, principle, masks, etchants, applications, advantages and limitation - Electro chemical machining (ECM), principle, components and functions, process parameters, material removal rate, inter electrode gap, tool design, electrolyte, applications, typical problems and limitations. (10)

ADVANCED PROCESSES: Magneto rheological finishing (MRF), Magneto rheological abrasive flow finishing (MRAFF) - hybrid processes - micromachining, classifications - Electrochemical spark micromachining (ECSSMM), equipments, process parameters, capabilities and applications. (12)

REFERENCES:

Total L: 45

21PP35 OPTIMIZATION TECHNIQUES


DYNAMIC PROGRAMMING: Principle of optimality, backward and forward recursion, calculus method of solution, tabular method of solution, shortest-route problem, knapsack model. (11)

NON-TRADITIONAL OPTIMIZATION ALGORITHMS: Genetic Algorithm, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization – algorithms and examples. (11)

REFERENCES:

21PP36 PLASTICITY OF METAL FORMING

THEORY OF PLASTICITY: Theory of plastic deformation - engineering stress and strain relationship – stress tensor - strain tensor - yield criteria’s - plastic stress strain relationship – plastic work - equilibrium conditions - incremental plastic strain, uniaxial tension test - mechanical properties - work hardening, compression test, bulge test, plane strain compression stress, plastic instability in uniaxial tension stress, plastic instability in biaxial tension stress. (11)

ANALYSIS OF METAL FORMING: Slab analysis - slip line method - upper bound solutions - statistically admissible stress field, numerical methods, contact problems - effect of friction - elasto-plastic behaviour - analysis of forging, rolling, extrusion and wire drawing processes - experimental techniques of the evaluation of metal forming. (12)

ANALYSIS OF SHEET METAL FORMING: Bending theory - cold rolling theory - anisotropic theory - general yield theory - sheet metal forming - elements used, mesh generation and formulation, equilibrium equations, consistent full set algorithm, numerical solutions procedures, examples of simulation of simple parts, benchmark tests, forming limit diagrams. (11)

ADVANCES IN METAL FORMING: Orbital forging - isothermal forging - warm forging - hot and cold isotropic pressing - high speed extrusion - rubber pad forming - micro blanking - superplastic forming - overview of powder metal techniques - powder rolling - tooling and process parameters. (11)

REFERENCES:

21PP37 PRECISION MACHINING


HIGH SPEED MACHINING: Principle - need for high speed/high velocity machining - determinants, fast machining, smart machines, tools and processes, characteristics - high speed spindle elements - machining parameters - precision tooling interface - dry and near dry machining process. (11)

MICROMACHINING: Classification, size effect, tool based micromachining - micro turning, micro milling, micro drilling, principles, applications - Electrolytic InProcess Dressing (ELID) grinding, case study examples, sustainability issues - Introduction to nano-machining, diamond turning. (10)

REFERENCES:
21PP38 PRODUCT DEVELOPMENT STRATEGIES


CONCEPT DEVELOPMENT AND EMBODIMENT DESIGN: Information gathering, brain ball, C-sketche/6-3-5 method, morphological analysis - concept selection – pugh chart, weighted decision matrix - embodiment design, system modellung, FMEA, fault tree analysis, design verification. (12)

PHYSICAL PROTOTYPES AND EXPERIMENTATION: Types of prototypes and uses - rapid prototyping techniques - scale, dimensional analysis and similitude - physical model and experimentation - analysis, performance verification and validation - product teardown methods. (11)

TOOLING FOR PRODUCT DESIGN: Reverse Engineering: Data collection, mesh reconstruction, surface fitting, computer vision - reverse engineering hardware and software, applications - Product life cycle management (PLM), Product data management (PDM) - Collaborative product commerce (CPC) - sustainability in product design, guidelines. (10)

REFERENCES:

21PP39 PRODUCTION AND OPERATIONS MANAGEMENT

CAPACITY PLANNING: Long range capacity planning - economies of scale - facility location - factors influencing facility location, single facility location problem, multi facility location problem, minimax location problem, gravity location problem, Euclidean distance location problem - facility layout - classification of layout, systematic layout design procedure, CRAFT. (11)

PRODUCTION PLANNING AND INVENTORY MANAGEMENT: Aggregate planning - graphical, heuristic and transportation model - development of a master production schedule - make-to-stock, assemble-to-order, make-to-order/engineer-to-order - material requirement planning - lot sizing in MRP - manufacturing resource planning - enterprise resource planning - need for inventory - types of inventory, continuous and periodic review policies, EOQ, EMQ models, inventory model with purchase discounts, inventory models with uncertain demand and lead times, selective inventory control techniques. (12)

SEQUENCING AND SCHEDULING: Single machine models - priority rules, mean flow time, weighted mean flow time, number of tardy jobs, mean tardiness - parallel machine models - minimizing makespan, weighted mean flow time - flow shop models - johnson’s algorithm - job shop models - branch and bound approach - line balancing – largest candidate rule, kibridge and wester’s method, ranked positional weights method. (11)

LEAN PRODUCTION AND SUPPLY CHAIN MANAGEMENT: Elements of lean production - mrp vs jit - cycle time - takt time - kanban - smed - 5s - theory of constraints - agile manufacturing - maintenance management - statistics of failure, time to failure, probability distributions, bathtub curve, weibull’s probability distribution, reliability engineering, preventive maintenance, total productive maintenance, overall equipment effectiveness - supply chain management - definition, global optimization, bullwhip effect, push pull supply chain, delayed differentiation, downward substitution, product modularity, process modularity, mass customization. (11)

REFERENCES:

21PP40 STATISTICAL QUALITY CONTROL AND FACTORIAL EXPERIMENTS

STATISTICAL QUALITY CONTROL: Methods and philosophy of statistical process control – chance and assignable causes of quality variation - statistical basis of control charts - control charts for variables - control charts for attributes. (10)
ACCEPTANCE SAMPLING: Lot-by-Lot acceptance sampling for attributes – single sampling plans for attributes, double and sequential sampling plans - acceptance sampling by variables - chain sampling - continuous sampling - skip-lot sampling plans. (12)

DESIGN OF EXPERIMENTS: Fundamentals of experimental design - guidelines for designing experiments - analysis of variance - completely randomized design - randomized block design - Latin square design. (12)

RESPONSE SURFACE METHODOLOGY: Empirical models – linear regression models, estimation of parameters in linear regression models - confidence interval in multiple regression - 2-level factorial design – 2\(^3\) design for fitting second order models – class of central composite design. (11)

REFERENCES:

21PP41 SUSTAINABLE MANUFACTURING


SOCIO ECONOMIC SUSTAINABILITY: Role of Manufacturing in Sustainable Economic Development- Corporate social responsibility, Labour practice Indicators. Risk/benefit assessment & Corporate Social Responsibility, Maximization of customer satisfaction, Improvement of safety and health of employees, Green Supply chain. (10)


REFERENCES:

21PP42 TOOL DESIGN

CUTTING TOOLS: Cutting tool materials - single point cutting tool - form tool - hole making cutting tools - milling cutter - broaching tool - grinding wheel - ISO standard for inserts, tool holders - selection of inserts and tool holders for specific applications - gear shaper and gear hob design. (11)

JIGS AND FIXTURES: Principles of location - clamping and support - drill bushes - general considerations for design of jigs and fixtures - types of drill jigs - milling fixture - turning fixture - welding fixture - modular fixture - broaching fixture - grinding fixture - design of drill jig and fixture. (12)


INJECTION MOULDS: Elements of mould - types of injection mould - mould material - number of cavities - selection of mould and moulding machine - parting line and surface - feed system - ejection system - temperature control system - design of two plate and three plate mould. (11)

Total L: 45
REFERENCES:

21PP43 RESEARCH METHODOLOGY

3 0 0 3

REVIEW OF LITERATURE AND RESEARCH PROBLEM: Reviewing of literature in the area of study, preparing a list of reference materials, methods to search information effectively, Reference management software like Mendeley/ Zotero, Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem. (12)

DATA ANALYSIS: Statistical data, statistical measures, regression and correlation analysis, curve fitting, independence of attributes - analysis of contingency table, common scientific software for computation and analysis. (10)

RESEARCH ETHICS AND TECHNICAL RESEARCH: Ethical issues related to publishing, Online journal system, peer reviewed journals, Citation counting, Impact Factor, Scopus, SCI, H-index, G-index, SCIE, ORCID, DOI, Intellectual property rights (IPR), plagiarism. (12)

REPORTING AND THESIS WRITING: Writing of research articles and research proposals, structure of a manuscript, publication process of a manuscript, structure of a PhD thesis, Latex software for thesis formatting and effective presentation, software for detection of Plagiarism. (11)

Total L: 45

REFERENCES:

Open Electives (one to be opted)

21PP91 LEADERSHIP QUALITIES FOR ORGANIZATION

3 0 0 3

LEADER: Definition - traits of leader in ancient literature - historical leaders in industry - classification - born or nurtured leader - leadership in transition - leadership models - leadership trait theory - leadership behaviour theory - contingency theory and situational leadership theory - leadership style - authoritarian - democratic - free-rein style. (11)

LEADERSHIP CHARACTER: Integrity - communication - conflict resolution - transparency - clarity - learning leadership skills-soft skills - hard skills - emotional intelligence - behaviour - distinctive characters of past, present and future leaders. (11)

LEADERSHIP CHALLENGES: Critical leadership competencies - interpersonal skills - controlling - decision-making - role in change management - quality management - business ethics on leadership - future leader’s commitments and challenges - overcoming technical - political and cultural changes - challenges in quality systems - industrial act - environment and safety. (12)

BUILDING LEADERSHIP CAPACITY: Level of leadership - building volunteer leaders - training, development - empowerment - coaching - collaboration - economic development - professional leaders - leader vs. manager - accountability - outcome based-facilitator and consensus builder. (11)

Total L: 45

REFERENCES:

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