JNTUA COLLEGE OF ENGINEERING (AUTONOMOUS): ANANTAPURAMU
DEPARTMENT OF MECHANICAL ENGINEERING

M.Tech (Advanced Manufacturing Systems)

(4 SEMESTER COURSE STRUCTURE AND SYLLABUS)

EFFECTIVE FROM THE YEAR 2016-17

I- SEMESTER:

Subject Code	SUBJECT	L	P	C
16D35101	Automation in Manufacturing	4	-	4
15D34103	Computer Aided Manufacturing	4	-	4
16D35102	Precision Engineering	4	-	4
15D34102	Materials Technology	4	-	4
	ELECTIVE-I	4	-	4
16D35103	Special Manufacturing Process			
16D35104	Product Data Management			
15D31110	Total Quality Management			
	ELECTIVE-II	4	-	4
15D34109	Composite Materials and Mechanics			
16D35105	Advanced Mechatronics			
15D34110	Enterprise Resource Planning			
16D35106	Advanced CAD/CAM Lab	0	4	2
TOTAL		**24**	**4**	**26**

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – ADVANCED MANUFACTURING SYSTEMS

I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

AUTOMATION IN MANUFACTURING (16D35101)

UNIT – I

OVER VIEW OF MANUFACTURING AND AUTOMATION: Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers.

UNIT – II:

MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES: Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

UNIT – III:

MANUFACTURING SYSTEMS AND AUTOMATED PRODUCTION LINES: Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines.

UNIT – IV:

AUTOMATED ASSEMBLY SYSTEMS: Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis.

UNIT – V:

QUALITY CONTROL AND SUPPORT SYSTEMS: Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact Vs non contact, CMM. Manufacturing support systems. Quality function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.

REFERENCES:

1. Automation, production systems and computer integrated manufacturing/ Mikell.PGroover/PHI/3rd edition/2012.
2. Automation, Production Systems and CIM/ Mike J P. Grower/PHI
3. CAD/CAM/CIM/ P. **R**adha Krishnan **& S**. Subrahamanyarn and Raju/New Age International Publishers/2003.
4. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley /96.
5. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009.
6. Manufacturing and Automation Technology / R Thomas Wright and Michael Berkeihiser / Good Heart/Willcox Publishers.

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COMPUTER AIDED MANUFACTURING (15D34103)

UNIT - I

COMPUTE-AIDED PROGRAMMING: General information, APT programming, Examples Apt programming problems (2D machining only). NC programming on CAD/CAM systems, the design and implementation of post processors .Introduction to CAD/CAM software, Automatic Tool Path generation.

UNIT - II

TOOLING FOR CNC MACHINES: Interchangeable tooling system, preset and qualified toois, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages arid disadvantages of DNC, adaptive control with optimization, Adaptive control with constrains, Adaptive control of machining processes like turning, grinding.

UNIT - III

POST PROCESSORS FOR CNC:

Introduction to Post Processors: The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor: Communication channels and major variables in the DAPP — based Post Processor, th creation of a DAPP— Based Post Processor.

UNIT - IV

MICRO CONTROLLERS: Introduction, Hardware components, I/O pins, ports, external memory:, counters, timers and serial data I/O interrupts. Selection of Micro Controllers Embedded Controllers, Applications and Programming of Micro Controllers. Programming Logic Controllers (PLC' s): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.

UNIT - V

COMPUTER AIDED PROCESS PLANNING: Hybrid CAAP System, Computer Aided Inspection and quality control, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures.

REFERENCES:

1. Computer Control of Manufacturing Systems / YoramKoren / McGraw Hill. 1983.
2. Computer Aided Design Manufacturing – K. Lalit Narayan, K. MallikarjunaRao and M.M.M. Sarcar, PHI, 2008.
3. CAD/CAM Principles and Applications, P.N.Rao, TMH
4. CAD / CAM Theory and Practice,/ Ibrahim Zeid,TMH
5. CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age
6. Principles of Computer Aided Design and Manufacturing, FaridAmirouche, Pearson

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I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

PRECISION ENGINEERING (16D35102)

(Common to Advanced Manufacturing Systems & Quality Engineering & Management)

UNIT I:

CONCEPTS OF ACCURACY: Introduction – Concept of Accuracy of Machine Tools – Spindle and Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity lags.

GEOMETIC DEIMENSIONING AND TOLERANCING: Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datum's – Datum Feature of Representation – Form controls, Orientation Controls – Logical Approach to Tolerancing.

UNIT II:

DATUM SYSTEMS: Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

UNIT III:

TOLERANCE ANALYSIS: Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects, Feature Tolerances, Geometric Tolerances. Surface finish, Review of relationship between attainable tolerance grades and different machining process, Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

UNIT IV:

TOLERANCE CHARTING TECHNIQUES: Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples, Design features to facilitate machining; Datum Features – functional and manufacturing Components design – Machining Considerations, Redesign for manufactured, Examples.

UNIT V:

FOUNDAMENTALS OF NANOTECHNOLGY: Systems of nanometer accuracies – Mechanism of metal Processing – Nano physical processing of atomic bit units. Nanotechnology and Electrochemical atomic bit processing.

MEASURING SYSTEMS PROCESSING: In processing or in-situ measurement of position of processing point-Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems.

REFERENCES:

1. Precision Engineering in Manufacturing/Murthy R.L./New Age International (P) limited, 1996.
2. Geometric Dimensioning and Tolerancing / James D. Meadows / Marcel Dekker inc. 1995.
3. Nano Technology / Norio Taniguchi / Oxford University Press, 1996.
4. Engineering Design – A systematic Approach / Matousek / Blackie & Son Ltd., London
5. Precision Engineering/VC Venkatesh& S Izman/TMH

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I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

MATERIALS TECHNOLOGY (15D34102)

UNIT I:

Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non-crystalline material

UNIT II:

Griffith's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.

UNIT III:

Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis.

UNIT IV:

Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep. Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing, Case studies in Materials Selection with relevance to Aero, Auto , Marine, Machinery and Nuclear Applications.

UNIT V:

MODERN METALLIC MATERIALS: Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Managing Steel, Inter metallic, Ni and Ti Aluminides, Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials.

NONMETALLIC MATERIALS: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, $A1_2\ O_3$, SiC, $Si_3\ N_4$, CBN and Diamond – properties, Processing and applications.

REFERENCES:

1. Mechanical Behavior of Materials/Thomas H. Courtney/ McGraw Hill/2 nd Edition/2000
2. Mechanical Metallurgy/George E. Dicter/McGraw Hill, 1998.
3. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann.
4. Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson
5. Material Science and Engineering/William D Callister/John Wiley and Sons

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I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

SPECIAL MANUFACTURING PROCESS (16D35103)

(ELECTIVE – I)

UNIT- I

SURFACE TREATMENT: Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT- II

PROCESSING OF CERAMICS: Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT- III

FABRICATION OF MICROELECTRONIC DEVICES:

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics.

UNIT - IV

E-MANUFACTURING: Nano manufacturing techniques and micromachining, High Speed Machining and hot machining

UNIT -V

RAPID PROTOTYPING: Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing

REFERENCES:

1. Manufacturing Engineering and Technology *I*Kalpakijian / Adisson Wesley, 1995.
2. Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.
3. Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostr and Renihold,
4. MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH
5. Advanced Machining Processes / V.K.Jain / Allied Publications.
6. Introduction to Manufacturing Processes / John A Schey*I*McGraw Hill.

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I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

PRODUCT DATA MANAGEMENT (16D35104)

(ELECTIVE – I)

UNIT- I

Introduction -Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and costumer – behavior analysis. Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

UNIT - II

CONCEPT GENERATION AND SELECTION: Task – Structured approaches – Clarification – Search –Externally and internally – explore systematically – reflect on the solutions and process – concept selection– methodology – benefits.

PRODUCT ARCHETECTURE: Implications – Product change – variety – component standardization –product performance – manufacturability.

UNIT - III

PRODUCT DEVELOPMENT MANAGEMENT: Establishing the architecture – creation – clustering –geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

INDUSTRIAL DESIGN: Integrate process design – Managing costs – Robust design – Integrating CAE,CAD, CAM tools – simulating product performance and manufacturing processing electronically – Need for industrial design – impact – design process.

UNIT - IV

Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

UNIT - V

DESIGN FOR MANUFACTURING AND PRODUCTY DEVELOPMENT: Definition – Estimation ofmanufacturing cost – reducing the component costs and assembly costs – Minimize system complexity. Prototype basics – Principles of prototyping – planning for prototypes – Economics analysis – Understanding and representing tasks – baseline project planning – accelerating the project execution.

REFERENCES:

1. Product Design and Development / Kari T. Ulrich and Steven D. Eppinger / McGraw Hill International Edns. 1999.

2. Concurrent Engg/integrated Product development / Kemnneth Crow / DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310)377-569, Workshop Book.
3. Effective Product Design and Development / Stephen Rosenthal / Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.

4. Tool Design–Integrated Methods for Successful Product Engineering / Staurt Pugh / Addsion Wesley Publishing, Neyourk, NY, 1991, ISBN 0-202-41369-5.
5. Production and Operations Management/Chase/TMH

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I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

TOTAL QUALITY MANAGEMENT (15D31110)

(ELECTIVE – I)

UNIT – I:

INTRODUCTION: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT – II:

CUSTOMER FOCUS AND SATISFACTION: The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT – III:

ORGANIZING FOR TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

UNIT – IV:

THE COST OF QUALITY: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT – V:

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-90. Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system.

REFERENCES:

1. Total Quality Management / Joel E.Ross/Taylor and Franscis Limited
2. Total Quality Management/P.N.Mukherjee/PHI
3. Beyond TQM / Robert L.Flood
4. Statistical Quality Control / E.L. Grant / McGraw Hill.
5. Total Quality Management- A Practical Approach/H. Lal
6. Quality Management/KanishkaBedi/Oxford University Press/2011
7. Total Engineering Quality Management/Sunil Sharma/Macmillan

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I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

COMPOSITE MATERIALS AND MECHANICS (15D34109)

(ELECTIVE – II)

(Common to Product Design & Advanced Manufacturing Systems)

UNIT I
INTRODUCTION TO COMPOSITE MATERIALS
Definition-Matrix materials-polymers-metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite wood, Jute - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites.

UNIT II
MANUFACTURING OF COMPOSITES
Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-, bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - Solid state, liquid state,vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) –hot pressing-reaction bonding process-infiltration technique, direct oxidation- interfaces

UNIT III
INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS
Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke‟s Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Q_{ij}), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT IV
LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES
Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill‟s Criterion for Anisotropic materials. Tsai-Hill‟s Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

UNIT V

THERMAL ANALYSIS

Assumption of Constant Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke‟s Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E‟s. C.T.E‟s for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates

REFERENCES

1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994,
Second Edition - CRC press in progress.
2. Hyer, M.W., “Stress Analysis of Fiber – Reinforced Composite Materials”, McGraw-Hill, 1998
3. Issac M. Daniel and Ori Ishai, “Engineering Mechanics of Composite Materials”,
Oxford University Press-2006, First Indian Edition - 2007
4. Mallick, P.K., Fiber –”Reinforced Composites: Materials, Manufacturing and Design”, Maneel Dekker Inc, 1993.
5. Halpin, J.C., “Primer on Composite Materials, Analysis”, Techomic Publishing Co., 1984.
6. Agarwal, B.D., and Broutman L.J., “Analysis and Performance of Fiber Composites”, John Wiley and Sons, New York, 1990.
7. Mallick, P.K. and Newman, S., (edition), “Composite Materials Technology: Processes and Properties”, Hansen Publisher, Munish, 1990.
8. Madhujit Mukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)
9. Chung, Deborah D.L., “Composite Materials: Science and Applications”, Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint, 2009

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I- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

ADVANCED MECHATRONICS (16D35105)

(ELECTIVE – II)

UNIT-I

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT-II

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

UNIT-III

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.

UNIT-IV

Digital electronics and systems, digital logic control, micro-processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT-V

System and interfacing and data acquisition, DAQS, SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

REFERENCES:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran& GK Vijaya Raghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.
3. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
4. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
5. Mechatronics System Design / Devdasshetty/Richard/Thomson.
6. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
7. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton
8. Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print

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I- SEMESTER	**L**	**P**	**C**
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ENTERPRISE RESOURCE PLANNING (15D34110)

(ELECTIVE – II)

(Common to Product Design & Advanced Manufacturing Systems)

UNIT I
ENTERPRISE RESOURCE PLANNING
Principle – ERP framework – Business Blue Print – Business Engineering's Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

UNIT II
TECHNOLOGY AND ARCHITECTURE
Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing – chain safety – Evaluation framework.

UNIT III
ERP SYSTEM PACKAGES
SAP,.People soft, Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organisational and social issues.

UNIT IV
Overview – Architecture – AIM – applications – Oracle SCM. SAP : Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO, including ERP on the NET

UNIT V
ERP PROCUREMENT ISSUES
Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI – Analysis of cases from five Indian Companies.

REFERENCES:
1. Sadagopan.S , ERP-A Managerial Perspective, Tata Mcgraw Hill, 1999.
2. Jose Antonio Fernandez , The SAP R/3 Handbook, Tata Mcgraw Hill, 1998.
3. Vinod Kumar Crag and N.K.Venkitakrishnan ,Enterprise Resource Planning –Concepts and Practice, Prentice Hall of India, 1998.
4. ERPWARE , ERP Implementation Framework, Garg&Venkitakrishnan, Prentice Hall, 1999.
5. Thomas E Vollmann and BeryWhybark , Manufacturing and Control Systems, Galgothia Publications, 1998.

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I- SEMESTER	**L**	**P**	**C**
	0	**4**	**2**

ADVANCED CAD/CAM LAB (16D35106)

Features and selection of CNC turning and milling centers.

Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles.

Practice in part programming and operating a machining center, tool panning and selection of sequences of operations, tool setting on machine, practice in APT based NC programming.

Practice in Robot programming and its languages.

Robotic simulation using software. Robo path control, preparation of various reports and route sheets, Simulation of manufacturing system using CAM software, controller operating system commands

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II - SEMESTER:

Subject Code	SUBJECT	L	P	C
16D35201	Simulation Modeling of Manufacturing Systems	4	-	4
16D35202	Quality Engineering in Manufacturing	4	-	4
15D34201	Design for Manufacturing	4	-	4
16D35203	Production and Operations Management	4	-	4
	ELECTIVE-III	4	-	4
16D35204	Industrial Robotics			
15D34207	Additive Manufacturing			
16D35205	Design and Manufacturing of MEMS and Micro Systems			
	ELECTIVE-IV	4	-	4
16D35206	Performance Modelling and Analysis of Manufacturing Systems			
16D35207	Intelligent Manufacturing Systems			
16D35208	Optimization Techniques			
15D54201	Research Methodology (Audit Course)			
16D35209	Manufacturing Simulation Lab	0	4	2
TOTAL		**24**	**4**	**26**

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II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

SIMULATION MODELING OF MANUFACTURING SYSTEMS (16D35201)

UNIT - I

System - ways to analyze the system - Model - types of models - Simulation - Definition - Types of simulation models - steps involved in simulation - Advantages & Disadvantages. Parameter estimation - estimator - properties - estimate - point estimate - confidence interval estimates - independent - dependent - hypothesis - types of hypothesis- step - types l& 2 errors - Framing - string law of large numbers.

UNIT - II

Building of Simulation model validation - verification - credibility - their timing - principles of valid simulation Modeling - Techniques for verification - statistical procedures for developing credible model. Modeling of stochastic input elements - importance - various procedures - theoretical distribution - continuous - discrete their suitability in modeling.

UNIT - III

Generation of random variables - factors for selection methods - inverse transform - composition - convolution - acceptance - rejection - generation of random variables - exponential - uniform - weibull - normal Bernoullie - Binomial uniform - poisson - Simulation languages - comparison of simulation languages with general purpose languages Simulation languages vs Simulators - software features - statistical capabilities - G P S S - S1MAN- SIMSCRIPT - Simulation of WMJI queue - comparison of simulation languages.

UNIT - IV

Output data analysis - Types of Simulation w. r. t output data analysis – warm up period- Welch algorithm - Approaches for Steady - State Analysis - replication - Batch means methods - corn pan Sons.

UNIT - V

Applications of Simulation - flow shop system - job shop system - M/MI1 queues with infinite and finite capacities - Simple fixed period inventory system – New boy paper problem.

REFERENCES:

1. Simulation Modelling and Analysis / Law, A.M.&Kelton / McGraw Hill, Edition/ New York, 1991.

2. Discrete Event System Simulation *I* Banks J. & Carson J.S., PH *I* Englewood Cliffs N/ 1984.
3. Simulation of Manufacturing Systems / Carrie A. / Wiley, NY, 1990.

4. A Course in Simulation / Ross, S.M., McMillan, NY, 1990.
5. Simulation Modelling and S1MNET/ Taha HA. / PH, Englewood Cliffs, NJ, 1987

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – ADVANCED MANUFACTURING SYSTEMS

II- SEMESTER	**L**	**P**	**C**
	4	**-**	**4**

QUALITY ENGINEERING IN MANUFACTURING (16D35202)

UNIT - I

QUALITY VALUE AND ENGINEERING: An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances.(N-type,S-type and L-type)

UNIT II:

TOLERANCE DESIGN AND TOLERANCING: Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation fbr multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

UNIT – III

ANALYSIS OF VARIANCE (ANOVA): Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT - IV

ORTHOGONAL ARRAYS: Typical test strategies, better test strategies, efficient test strategies, steps indesigning, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

UNIT - V

SIX SIGMA AND THE TECHNICAL SYSTEM: Six sigma DMAIC methodology, tools fpr process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.

REFERENCES:

1. Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995.
2. Quality Engineering in Production systems *I* G. Taguchi, A. Elsayed et al /Mc.Graw Hill Intl. Edition, 1989.
3. Taguchi Methods explained: Practical steps to Robust Design /Papan P. Bagchi*I* Prentice Hall Pvt. Ltd., New Delhi.

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DESIGN FOR MANUFACTURING (15D34201)
(Common to Product Design & Advanced Manufacturing Systems)

UNIT-I

System Concept-Elements of System- Types and Characteristics of System-System Design Approach- System Development- Stages and phases of Development-Documentation and Models in System Development

System Modelling and Theories, Modelling Process, System Theory, Black Box Approach and State Approach

UNIT-II

Mathematical Formulation in System design, LPP with Graphical solution, - Network Flow Analysis

System Evaluation, Evaluation Factors, Needs for Evaluation, Benefits, Types and Stages in System Evaluation

UNIT-III

System Reliability, Block diagram, Block Failure, Definition of Reliability, Reliability and Probability, Failure Rate, Estimation, Reliability Indices. Reliability Tests.

UNIT-IV

System simulation- Need for Simulation, Steps in simulation, Simulation Models.

System Approach to Project Management- Project Management Systems and Functional management System, Classification, Techniques and Objectives.

UNIT-V

Manufacturing Systems-Classifications, Introduction to FMS and Computer Integrated Manufacturing System - Concepts of Group Technology

TEXT BOOKS:

1. R.C.Mishra and Simant –"**Mechanical System Design"**
2. Arora.A.,and Bhatia A**-"Management Information System"**. Excell Publication, New Delhi
3. Gopal Krishna P., and P RamamoothyV.E., -"**Text Book of Project Management**", Macmillian, New Delhi.

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PRODUCTION AND OPERATIONS MANAGEMENT (16D35203)

(Common to Advanced Manufacturing Systems & Quality Engineering & Management)

UNIT -I

OPERATION MANAGEMENT: Definition – Objectives – Types of production systems – historical development of operations management – Current issues in operation management.

Product design – Requirements of good product design – product development – approaches – concepts in product development – standardization – simplification – Speed to market – Introduction to concurrent engineering.

UNIT – II

VALUE ENGINEERING: objective – types of values – function & cost – product life cycle-steps in value engineering – methodology in value engineers – FAST Diagram – Matrix Method.

Location – Facility location and layout – Factors considerations in Plant location- Comparative Study of rural and urban sites – Methods of selection plant layout – objective of good layout – Principles – Types of layout– line balancing.

UNIT - III

AGGREGATE PLANNING: definition – Different Strategies – Various models of Aggregate Planning –Transportation and graphical models.

Advance inventory control systems push systems – Material Requirement – Terminology – types of demands – inputs to MRP- techniques of MRP – Lot sizing methods – benefits and drawbacks of MRP – Manufacturing Resources Planning (MRP –II), Pull systems – Vs Push system – Just in time (JIT) philosophy Kanban System – Calculation of number of Kanbans Requirements for implementation JIT – JIT Production process – benefits of JIT.

UNIT - IV

SCHEDULING: Policies – Types of scheduling – Forward and Backward Scheduling – Gantt Charts – Flow shop Scheduling – n jobs and 2 machines, n jobs and 3 machines – job shop Scheduling – 2 jobs and n machines – Line of Balance.

UNIT – V

PROJECT MANAGEMENT: Programming Evaluation Review Techniques (PERT) – three times estimation– critical path – probability of completion of project – critical path method – crashing of simple nature.

REFERENCES:

1. Operations Management/ E.S. Buffs/ John Wiley & Sons / 2007
2. Operations Management Theory and Problems/ Joseph G. Monks / Macmillan / McGraw Hill / 3rd Edition.
3. Production Systems Management/ James I. Riggs / John Wiley & Sons.
4. Production and Operations Management/ Chary/ McGraw Hill/2004
5. Operations Management/ Richard Chase/ McGraw Hill/2006
6. Production and Operation Management / PannerSelvam / PHI.
7. Production and Operation Analysis/ Nahima/ McGraw Hill/2004

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II- SEMESTER	**L**	**P**	**C**
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INDUSTRIAL ROBOTICS (16D35204)

(ELECTIVE – III)

UNIT - I

INTRODUCTION: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement. **CONTROL SYSTEM AND COMPONENTS:** basic concept and modais controllers control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system.

UNIT - II

MOTION ANALYSIS AND CONTROL: Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller.

UNIT - III

END EFFECTORS: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics.

MACHINE VISION: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog todigital single conversion, image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

UNIT - IV

ROBOT PROGRAMMING: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINONAL AND DELAY commands, Branching capabilities and Limitations. **ROBOT LANGUAGES**: Textual robot Languages, Generation, Robot language structures, Elements in function.

UNIT - V

ROBOT CELL DESGIN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detect ion, Work wheel controller.

ROBOT APPLICATION: Material transfer, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application.

REFERENCES:

1. Industrial Robotics / Groover M P /Pearson Edu.
2. Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition.
3. Robotics / Fu K S/ McGraw Hill.
4. Robotic Engineering / Richard D. Klafter, Prentice Hall
5. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science.
6. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) Pte Ltd.
7. Robotics and Control / Mittal R K &Nagrath I J / TMH

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ADDITIVE MANUFACTURING (15D34207)
(Elective-III)
(Common to Product Design & Advanced Manufacturing Systems)

UNIT I
INTRODUCTION:
Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications.

UNIT II:
REVERSE ENGINEERING AND CAD MODELING:
Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III
LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS:
Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications. Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV
POWDER BASED ADDITIVE MANUFACTURING SYSTEMS: Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V
OTHER ADDITIVE MANUFACTURING SYSTEMS
Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

REFERENCES

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
3. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.
5. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
6. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

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II- SEMESTER	**L**	**P**	**C**
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DESIGN AND MANUFACTURING OF MEMS AND MICRO SYSTEMS (16D35205)

(ELECTIVE – III)

UNIT I:

OVERVIEW AND WORKING PRINCIPLES OF MEMS AND MICROSYSTEMS

MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & Miniaturization, Applications of MEMS in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidies.

UNIT II:

ENGINEERING SCIENCE FOR MICROSYSTEMS DESIGN AND FABRICATION:

Atomic structure of Matter, Ions and Ionization, Molecular Theory of Mater and Intermolecular Force, Doping of Semiconductors, The diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics

UNIT III:

ENGINEERING MECHANICS FOR MICROSYSTEMS DESIGN:

Static Bending of thin Plates, Mechanical Vibration, Thermo mechanics Fracture Mechanics, Thin-Film Mechanics, Overview of Finite Element Stress Analysis

UNIT IV:

THERMO FLUID ENGINEERING & MICROSYSTEMS DESIGN:

Overview of Basics of Fluid Mechanics in Macro and Meso scales, Basic equations in Continuum Fluid dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid Flow in Sub micrometer and Nano scale, Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin films and in solids in sub micrometer scale, Design Considerations, Process Design Mechanical Design, Mechanical Design using FEM, Design of a Silicon Die for a Micro pressure Sensor.

UNIT V:

MATERIALS FOR MEMS & MICROSYSTEMS AND THEIR FABRICATION:

Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon Compounds, Silicon Piezoresistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, chemical and physical vapor deposition, Etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process

REFERENCES:

1. MEMs & Microsystems: Design & Manufacture/ Tai-Ran Hsu/Tata Mc-Graw Hill., ed./2002
2. An Introduction to Microelectromechanical Systems Engineering/ Maluf, M./ Artech House, Boston, 2000
3. Micro robots and Micromechanical Systems/ Trimmer, W.S.N/ Sensors & Actuators, vol19, no.1989.
4. Applied Partial Differential Equations/ Trim, D.W/ PWS-Kent Publishing/ Boston 1990.
5. Fundamentals of Microfabrication. Madou, M/ CRC Press, Boca Raton, 1997.
6. The Finite Element Method in Thermomechanics/ Hsu, T.R / Alien &Unwin, London.

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PERFORMANCE MODELLING AND ANALYSIS OF MANUFACTURING SYSTEMS

(16D35206)

(ELECTIVE – IV)

UNIT I:

MANUFACTURING SYSTEMS & CONTROL:

Automated Manufacturing Systems – Modeling – Role of performance modeling – simulation models-Analytical models.Product cycle – Manufacturing automation – Economics of scale and scope – input/output model – plant configurations. Performance measures – Manufacturing lead time – Work in process – Machine utilization – Throughput – Capacity – Flexibility – Performability – Quality Control Systems – Control system architecture – Factory communications – Local area network interconnections – Manufacturing automation protocol – Database management system.

UNIT II:

MANUFACTURING PROCESSES:

Examples of stochastics processes – Poisson process - Discrete time Markov chain models – Definition and notation – Sojourn times in states – Examples of DTMCs in manufacturing – Chapman – Kolmogorov equation – Steady-state analysis. Continuous Time Markov Chain Models – Definitions and notation – Sojourn times in states – examples of CTMCs in manufacturing – Equations for CTMC evolution – Markov model of a transfer line.Birth and Death Processes in Manufacturing – Steady state analysis of BD Processes – Typical BD processes in manufacturing.

UNIT III:

QUEUING MODEL:

Notation for queues – Examples of queues in manufacturing systems – Performance measures – Little's result – Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns – Analysis of a flexible machine center.

UNIT IV:

QUEUING NETWORKS:

Examples of QN models in manufacturing – Little's law in queuing networks – Tandem queue – An open queuing network with feedback – An open central server model for FMS – Closed transfer line – Closed server model – Garden Newell networks.

UNIT V:

PETRINETS:

Classical Petri Nets – Definitions – Transition firing and reachability – Representational power – properties – Manufacturing models.

Stochastic Petri Nets – Exponential timed Petri Nets – Generalized Stochastic Petri Nets – modeling of KANBAN systems – Manufacturing models.

REFERENCES:

1. Performance Modelling of Automated Manufacturing Systems/ Viswanadham, N and Narahari, Y/ Prentice Hall of India, New Delhi, 1994
2. Probability and Statistics with Reliability, Queuing and Computer Science Applications/ Trivedi, K.S./ Prentice Hall, New Jersey, 1982.
3. Fundamentals of Mathematical Statistics/ Gupta S.C. &Kapoor V.K./ 3rd Edition, Delhi, 1988

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INTELLIGENT MANUFACTURING SYSTEMS (16D35207)

(ELECTIVE – IV)

UNIT I:

Computer Integrated Manufacturing Systems Structure and functional areas of CIM system, - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM. Manufacturing Communication Systems - MAP/TOP, OSI Model, Data Redundancy, Top- down and Bottom-up Approach, Volume of Information. Intelligent Manufacturing System Components, System Architecture and Data Flow, System Operation.

UNIT II:

Components of Knowledge Based Systems - Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

UNIT III:

Machine Learning - Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing.

UNIT IV:

Automated Process Planning - Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning. Knowledge Based System for Equipment Selection (KBSES) - Manufacturing system design. Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KRSES.

UNIT V:

Group Technology: Models and Algorithms Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation - Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System. Structure of Knowledge based system for group technology (KBSCIT) — Data Base, Knowledge Base, Clustering Algorithm.

REFERENCES:

1. Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.

2. Artificial Neural Networks/ YagnaNarayana/PHI/2006
3. Automation, Production Systems and CIM / Groover M.P./PHI/2007
4. Neural networks: A comprehensive foundation/ Simon Hhaykin/ PHI.
5. Artificial neural networks/ B.Vegnanarayana/PHI
6. Neural networks in Computer intelligence/ Li Min Fu/ TMH/2003
7. Neural networks/ James A Freeman David M S kapura/ Pearson education/2004
8. Introduction to Artificial Neural Systems/Jacek M. Zurada/JAICO Publishing House Ed. 2006.

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OPTIMIZATION TECHNIQUES (16D35208)

(ELECTIVE – IV)

(Common to Advanced Manufacturing Sysytems & Quality Engineering & Management)

Course Objectives:

1. To introduce the advanced optimization techniques such as classical optimization techniques, numerical optimization techniques and genetic algorithms.

2. Learn the knowledge to formulate optimization problems

UNIT - I
Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

UNIT - II
Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

UNIT - III
Genetic algorithm (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,

Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems

UNIT – IV
Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

UNIT V
Applications of Optimization in Design and Manufacturing systems: Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam and general optimization model of a machining process.

TEXT BOOKS:

1. Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers

REFERENCES:

1.Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Genetic Programming- Koza
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers

Course Out comes:

1. Students at the end of the course learn advanced optimization techniques to show real-life problems
2. Students can able to formulate and solve various practical optimization problems in manufacturing and service organizations

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RESEARCH METHODOLOGY (AUDIT COURSE) (15D54201)

DSLR

RESEARCH METHODOLOGY

(Audit Course For M.Tech. –II Semester Program from 2015 admitted batches onwards)

UNIT I

Meaning of Research – Objectives of Research – Types of Research – Research Approaches – Guidelines for Selecting and Defining a Research Problem – research Design – Concepts related to Research Design – Basic Principles of Experimental Design.

UNIT II

Sampling Design – steps in Sampling Design –Characteristics of a Good Sample Design – Random Sampling Design.

Measurement and Scaling Techniques-Errors in Measurement – Tests of Sound Measurement – Scaling and Scale Construction Techniques – Time Series Analysis – Interpolation and Extrapolation.

Data Collection Methods – Primary Data – Secondary data – Questionnaire Survey and Interviews.

UNIT III

Correlation and Regression Analysis – Method of Least Squares – Regression vs Correlation – Correlation vs Determination – Types of Correlations and Their Applications

UNIT IV

Statistical Inference: Tests of Hypothesis – Parametric vs Non-parametric Tests – Hypothesis Testing Procedure – Sampling Theory – Sampling Distribution – Chi-square Test – Analysis of variance and Co-variance – Multi-variate Analysis.

UNIT V

Report Writing and Professional Ethics: Interpretation of Data – Report Writing – Layout of a Research Paper – Techniques of Interpretation- Making Scientific Presentations in Conferences and Seminars – Professional Ethics in Research.

Text books:

1. Research Methodology:Methods and Techniques – C.R.Kothari, 2nd Edition,New Age International Publishers.
2. Research Methodology: A Step by Step Guide for Beginners- Ranjit Kumar, Sage Publications (Available as pdf on internet)
3. Research Methodology and Statistical Tools – P.Narayana Reddy and G.V.R.K.Acharyulu, 1st Edition,Excel Books,New Delhi.

References:

1. Scientists must Write - Robert Barrass (Available as pdf on internet)
2. Crafting Your Research Future –Charles X. Ling and Quiang Yang (Available as pdf on internet)

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DEPARTMENT OF MECHANICAL ENGINEERING
M.Tech – ADVANCED MANUFACTURING SYSTEMS

II- SEMESTER	**L**	**P**	**C**
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MANUFACTURING SIMULATION LABORATORY (16D35209)

The students will be given training on the use and application of the following software to manufacturing problems:

1. Auto MOD Software.
2. PROMOD
3. SLAM-II
4. CAFIMS
5. Flexsim

They also learn how to write sub routines in C-language and interlinking with the above packages. Problems for modelling and simulation experiments:

1. AGV planning
2. ASRS simulation and performance evaluation
3. Machines, AGVs and AS/RS integrated problems
4. JIT system
5. Kanban flow
6. Material handling systems
7. M.R.P. Problems
8. Shop floor scheduling etc.

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Course Structure of R21 Academic Regulations for M.Tech (Regular) Programs with effect from AY 2021-2022

DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED MANUFACTURING SYSTEMS

I SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D35101	Automation in Manufacturing	PC	3	0	0	3
2	21D35102	Computer Aided Manufacturing	PC	3	0	0	3
3	**Professional Elective – I**						
	21D35103	Precision Engineering	PE	3	0	0	3
	21D35104	Special Manufacturing Processes					
	21D35105	Product Data Management					
4	**Professional Elective – II**						
	21D35106	Design for Manufacturing and Assembly	PE	3	0	0	3
	21D35107	Advanced CAD					
	21D35108	Advanced Mechatronics					
5	21D11109	Research Methodology and IPR	MC	2	0	0	2
6	21D11110	English for Research Paper Writing	AC	2	0	0	0
	21D11111	Value Education					
	21D11112	Pedagogy Studies					
7	21D35109	Automation Lab	PC	0	0	4	2
8	21D35110	Metal Cutting Lab	PC	0	0	4	2
Total				**16**	**00**	**08**	**18**

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DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED MANUFACTURING SYSTEMS

II SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D35201	Simulation of Manufacturing Systems	PC	3	0	0	3
2	21D35202	Quality Engineering in Manufacturing	PC	3	0	0	3
3	**Professional Elective – III**						
	21D35203	Material Science & Technology	PE	3	0	0	3
	21D35204	Industrial Robotics					
	21D35205	Advanced Tool Design					
4	**Professional Elective – IV**						
	21D35206	Production & Operations Management	PE	3	0	0	3
	21D35207	Modeling of Manufacturing Systems					
	21D35208	Optimization Techniques					
5	21D11209	Technical Seminar	PR	0	0	4	2
6	21D11210	Disaster Management	AC	2	0	0	0
	21D11211	Constitution of India					
	21D11212	Stress Management by Yoga					
7	21D35209	Manufacturing Simulation Laboratory	PC	0	0	4	2
8	21D35210	Advanced CAD/CAM Laboratory	PC	0	0	4	2
Total				**14**	**00**	**12**	**18**

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DEPARTMENT OF MECHANICAL ENGINEERING

ADVANCED MANUFACTURING SYSTEMS

III SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	**Professional Elective – V**						
	21D35301	Total Quality Management	PE	3	0	0	3
	21D35302	Theory of Elasticity and Plasticity					
	21D35303	Design and Manufacturing of MEMS and Micro Systems					
2	**Open Elective**						
	21D30301	Mechatronics	OE	3	0	0	3
3	21D35304	Dissertation Phase – I	PR	0	0	20	10
4	21D00301	Co-Curricular Activities	PR				2
Total				**06**	**00**	**20**	**18**

IV SEMESTER

S.No.	Course Code	Subject Name	Cate Gory	Hours Per Week			Credits
				L	T	P	
1	21D34401	Dissertation Phase – II	PR	0	0	32	16
Total				**00**	**00**	**32**	**16**

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
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Course Code	21D35101	AUTOMATION IN MANUFACTURING	L	T	P	C
Semester	I	(21D35101)	3	0	0	3

Course Objectives: At the end of this course

- The course should enable to understand the principles of automation, importance of automated flow lines and its types.
- The Student should be able to understand outline the system configurations used in automated production
- Students should be able to recognize and articulate the foundational assumption of the transfer mechanism, types of transfer mechanism that may be used for work part transfer
- Student able to describe automated assembly systems, and their associated system configurations , list the hardware components used for parts delivery at workstations Outline typical automated assembly processes

Course Outcomes (CO): Student will be able to

- After completion of this unit students are able to understand to know what is automation, types of automation, components of automation, strategies and levels of automation
- After completion of this course students are able to understand to know what is automation, types of automation, components of automation, strategies and levels of automation
- After completion of this course students are able to understand the types of flow lines, quantitative analysis of flow lines, how the assembly is carried out on automated flow line without interruption and how to balance the line and flexible assembly lines
- Students are able to understand automated transfer and storage system, recognize the equipments used in automated transfer and storage system.

UNIT - I	OVER VIEW OF MANUFACTURING AND AUTOMATION	Lecture Hrs:09

Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers.

UNIT – II	MATERIAL HANDLING AND IDENTIFICATION TECHNOLOGIES	Lecture Hrs:09

Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode technology, RFID.

UNIT – III	MANUFACTURING SYSTEMS AND AUTOMATED PRODUCTION LINES:	Lecture Hrs:09

Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines.

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UNIT – IV	**AUTOMATED ASSEMBLY SYSTEMS**	Lecture Hrs:09
Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, cooling, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis		
UNIT – V	**QUALITY CONTROL AND SUPPORT SYSTEMS**	Lecture Hrs:09
Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact Vs non-contact, CMM. Manufacturing support systems. Quality function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.		

Textbooks:

1. Automation, production systems and computer integrated manufacturing/ Mikell.PGroover/PHI/3rd edition/2012.
2. Automation, Production Systems and CIM/ Mike J P. Grower/PHI

Reference Books:

1. CAD/CAM/CIM/ P. **R**adha Krishnan **& S**. Subrahamanyarn and Raju/New Age International Publishers/2003.
2. System Approach to Computer Integrated Design and Manufacturing/ Singh/John Wiley/96.
3. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wysk and Hsu-Pin Wang/ Pearson/ 2009

Online Learning Resources:

1. https://nptel.ac.in/courses/112/104/112104288/
2. https://nptel.ac.in/courses/112/103/112103293/
3. https://nptel.ac.in/courses/112/103/112103174/
4. https://youtu.be/v-3TmN4HhLc
5. https://youtu.be/-NINgz6KQTA
6. https://youtu.be/CmQa2xoQdzk
7. https://youtu.be/yeHE4se7u5M

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Course Code	21D35102	COMPUTER AIDED MANUFACTURING (21D35102)	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Computer Aided Manufacturing is highly demanded area now a day. Computer Aided Manufacturing deals with Design of components to manufacturing and also includes Planning and controlling the processes. Industries widely use CNC, FMS and Robotics technology now a day.
- Students will be familiar with its hardware and software and also able to write programs for machining.

Course Outcomes (CO): Student will be able to

- Students will describe basic concepts of CAM application and understand CAM wheel
- Students will prepare CNC programs for manufacturing of different geometries on milling and lathe machines.
- Students will prepare logic diagram for different application of automation.
- Students will classify different components using different techniques of group technology.
- Students will prepare Process planning for different components.
- Students will select layouts of FMS for industrial applications.
- Students will describe Robot for preliminary industrial applications like pick and place.
- Student will identify application of PPC, JIT, MRP-I, MRP-II, and Expert system to CAM.

UNIT – I	COMPUTER AIDED DESIGN AND PROGRAMMING	Lecture Hrs:09

General information, APT programming, Examples Apt programming problems. NC programming on CAD/CAM systems, post processing techniques, Introduction to CAD/CAM software, Automatic Tool Path generation.

UNIT – II	TOOLING FOR CNC MACHINES	Lecture Hrs:09

Interchangeable tooling system ,preset and qualified tools, modular fixturing , quick change tooling system, automatic head changers. DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages arid disadvantages of DNC, adaptive control with optimization, Adaptive control with constrains, Adaptive control of machining processes like turning, grinding, types of control systems-open loop and closed loop control systems.

UNIT – III	POST PROCESSORS FOR CNC	Lecture Hrs:09

Introduction to Post Processors: The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor: Communication channels and major variables in the DAPP — based Post Processor, th creation of a DAPP— Based Post Processor

UNIT - IV	MICRO CONTROLLERS	Lecture Hrs:09

Introduction, Hardware components, I/O pins, ports, external memory:,counters,timers and serial data I/O interrupts. Selection of Micro Controllers Embedded Controllers, Applications and Programming of Micro Controllers. Programming Logic Controllers (PLC' s): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.

UNIT - V	**COMPUTER AIDED PROCESS PLANNING**	Lecture Hrs:09
Hybrid CAAP System, Computer Aided Inspection and qualitycontrol, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures.		
Textbooks:		
1. Computer Control of Manufacturing Systems / YoramKoren / McGraw Hill. 1983. 2. Computer Aided Design Manufacturing – K. Lalit Narayan, K. MallikarjunaRao and M.M.M. Sarcar, PHI, 2008.		
Reference Books:		
1. CAD/CAM Principles and Applications, P.N.Rao, TMH 2. CAD / CAM Theory and Practice,/ Ibrahim Zeid,TMH 3. CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age 4. Principles of Computer Aided Design and Manufacturing, FaridAmirouche, Pearson		
Online Learning Resources:		
1. nptel.ac.in/courses/112/102/112102101/ 2. nptel.ac.in/courses/112/104/112104289/		

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Course Code	21D35103	PRECISION ENGINEERING (21D35103)	L	T	P	C
Semester	I	PE – I	3	0	0	3

Course Objectives:

- To impart knowledge about basics of precision machining and different Manufacturing technique in precision engineering.
- Accuracy and alignment tests.
- Influences of static stiffness and thermal effects.
- Precision machining.
- Nano measuringsystems.
- Various lithography techniques

Course Outcomes (CO): Student will be able to

- Apply fits and tolerances for parts and assemblies according to ISO standards
- Apply selective assembly concept for quality and economic production
- Assign tolerances using principles of dimensional chains for individual features of a part or assembly.
- Evaluate the part and machine tool accuracies.

UNIT - I	CONCEPTS OF ACCURACY	Lecture Hrs:09

Introduction – Concept of Accuracy of Machine Tools – Spindle and Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity lags.

GEOMETIC DEIMENSIONING AND TOLERANCING:

Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums – Datum Feature of Representation – Form controls, Orientation Controls – Logical Approach to Tolerancing.

UNIT - II	DATUM SYSTEMS	Lecture Hrs:09

Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

UNIT - III	TOLERANCE ANALYSIS	Lecture Hrs:09

Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects, Feature Tolerances, Geometric Tolerances. Surface finish, Review of relationship between attainable tolerance grades and different machining process, Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

UNIT - IV	TOLERANCE CHARTING TECHNIQUES	Lecture Hrs:09

Operation Sequence for typical shaft type of components,Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples, Design features to facilitate machining; Datum Features – functional and manufacturing Components design – Machining Considerations, Redesign for manufactured, Examples

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UNIT - V	**MEASURING SYSTEMS PROCESSING**	Lecture Hrs:09

MEASURING SYSTEMS PROCESSING: In processing or in-situ measurement of position of processingpoint-Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems.

Textbooks:

1. Precision Engineering in Manufacturing/Murthy R.L./New Age International (P) limited, 1996.
2. Geometric Dimensioning and Tolerancing / James D. Meadows / Marcel Dekker inc. 1995

Reference Books:

1. Nano Technology / Norio Taniguchi / Oxford University Press, 1996.
2. Engineering Design – A systematic Approach / Matousek / Blackie & Son Ltd., London
3. Precision Engineering/VC Venkatesh& S Izman/TMH

Online Learning Resources:

1. https://www.itsligo.ie/courses/beng-precision-engineering-design-online/
2. https://www.bachelorsportal.com/studies/249110/precision-engineering-and-design.html
3. https://engineering.purdue.edu/online/courses/precision-manufacturing-systems

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Course Code	21D35104	SPECIAL MANUFACTURING PROCESSES (21D35104)	L	T	P	C
Semester	I	PE – I	3	0	0	3

Course Objectives:

- To teach the students to understand the fundamentals of manufacturing and prototyping for product design and development.
- To teach the students to gain practical experience in manufacturing and prototyping for product design and development.
- To teach the students to develop ability to apply up-to-datetechnology in manufacturing products with considerations of safety and environmental factors

Course Outcomes (CO): Student will be able to

- Describe the principle and operation of common manufacturing and rapid prototyping processes for product development.
- Decide on the use of appropriate manufacturing processes in the manufacture of a product at the design stage.
- Develop a prototype with modern prototyping techniques.
- Apply up-to-date technology in manufacturing products withconsiderations of safety and environmental factors.
- Apply the reverse engineering process for product development.
- Appreciate and report on the common practice in the product development industry.

UNIT - I	SURFACE TREATMENT	Lecture Hrs:09

Scope, Cleaners, Methods of cleaning, Surface coating types, and ceramic and organic methods of coating, economics of coating. Electro forming, Chemical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding.

UNIT - II	PROCESSING OF CERAMICS	Lecture Hrs:09

Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, Drying, sintering, Hot compaction, Area of application, finishing of ceramics. Processing of Composites: Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites.

UNIT - III	FABRICATION OF MICROELECTRONIC DEVICES	Lecture Hrs:09

Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics.

UNIT - IV	E-MANUFACTURING	Lecture Hrs:09

Nano manufacturing techniques and micromachining, High Speed Machining andhot machining. Internet based e-manufacturing covers the range of manufacturing activities for products and services, including product design, production control and condition monitoring, supply chain management, maintenance and sales and services through the internet.

UNIT - V	RAPID PROTOTYPING	Lecture Hrs:09

Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing

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Textbooks:
1. Manufacturing Engineering and Technology *I*Kalpakijian / Adisson Wesley, 1995. 2. Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990.
Reference Books:
1. Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van NostrandRenihold, 2. MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH 3. Advanced Machining Processes / V.K.Jain / Allied Publications. 4. Introduction to Manufacturing Processes / John A Schey*I*McGraw Hill. 5. E-manufacturing applications and potentials – Kaiecherg, Richard,J. Bateman," Progress in Natural Science vol 18,Issue 11, November 2008, PP 1323-1328.
Online Learning Resources:
1. nptel.ac.in/courses/112/107/112107144/ 2. https://www.tandfonline.com/toc/lmmp20/current 3. https://alison.com/course/manufacturing-paradigms?utm_source=google&utm_medium=cpc&utm_campaign=PPC_Tier-4_Course-3070_Manufacturing-Paradigms&utm_adgroup=Course-3070_Manufacturing-Paradigms&gclid=Cj0KCQjw8p2MBhCiARIsADDUFVGxg_R-KK7tz4wKmikdyRr7h-3lSkUk7zH4BARh9c-5hn4vZ6KJHrUaAmjnEALw_wcB

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Course Code	21D35105	PRODUCT DATAMANAGEMENT (21D35105)	L	T	P	C
Semester	I	PE – I	3	0	0	3

Course Objectives:

- Familiarize the current principles, practices, and applications of Product Lifecycle Management (PLM).
- Aware that the sustainable design of product and process and the early consideration of the constraints and factors become more important to successfully develop competitive products.
- Learn integrated, information driven approach to all aspects of a product's life from its design inception, through its manufacture, deployment and maintenance, and culminating in its removal from service and final disposal.
- Aware that PLM technology is playing a critical role in most of the modern industries including aerospace, automobile, medical, etc.
- Experience effective integration of PLM technologies into the product development process that can put the industry at a competitive advantage to deliver innovative products ! Experience modern PLM strategies, methods, and tools.

Course Outcomes (CO): Student will be able to

- Remember the reasons for adopting PLM strategies and methods.
- Indentify PLM's impacts on corporate strategy, structure and operations.
- Distinguish product development processes.
- Distinguish associated engineering information with the product development process.
- Construct and manage product data using PLM/PDM technologies.
- Construct managed product data during the PD process.
- Defend information technology for supporting product development process.
- Distinguish the challenges in product data integration in product lifecycle.
- Construct general strategies and principles for the successful implementation.

UNIT - I	Introduction	Lecture Hrs:09

Need for IPPD – strategic importance of product development – integration of customer, designer, material supplier and process planner, Competitor and costumer – behavior analysis. Understanding customer – promoting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specification.

UNIT - II	CONCEPT GENERATION AND SELECTION	Lecture Hrs:09

Task – Structured approaches – Clarification – Search –Externally and internally – explore systematically – reflect on the solutions and process – concept selection– methodology – benefits.

PRODUCT ARCHETECTURE: Implications – Product change – variety – component standardization –product performance – manufacturability.

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UNIT - III	**PRODUCT DEVELOPMENT MANAGEMENT**	Lecture Hrs:09
Establishing the architecture – creation – clustering –geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications. **INDUSTRIAL DESIGN**: Integrate process design – Managing costs – Robust design – Integrating CAE,CAD, CAM tools – simulating product performance and manufacturing processing electronically – Need for industrial design – impact – design process.		
UNIT - IV	**Investigation of customer needs**	Lecture Hrs:09
Investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.		
UNIT - V	**DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT**	Lecture Hrs:09
Definition – Estimation of manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity. Prototype basics – Principles of prototyping – planning for prototypes – Economics analysis – Understanding and representing tasks – baseline project planning – accelerating the project execution.		

Textbooks:

1. Product Design and Development / Kari T. Ulrich and Steven D. Eppinger / McGraw Hill International Edns. 1999.
2. Concurrent Engg/integrated Product development / Kemnneth Crow / DRM Associates, 26/3, Via Olivera, Palos Verdes, CA 90274(310)377-569, Workshop Book.

Reference Books:

1. Effective Product Design and Development / Stephen Rosenthal / Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.
2. Tool Design–Integrated Methods for Successful Product Engineering / Staurt Pugh / Addsion Wesley Publishing, Neyourk, NY, 1991, ISBN 0-202-41369-5.
3. Production and Operations Management/Chase/TMH

Online Learning Resources:

1. nptel.ac.in/courses/112/107/112107217/
2. https://onlinecourses.nptel.ac.in/noc20_me69/preview
3. https://www.autodesk.com/solutions/pdm-product-data-management#:~:text=Product%20data%20management%20(PDM)%20is,(BOMs)%2C%20and%20more.
4. https://en.wikipedia.org/wiki/Product_data_management

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Course Code	21D35106	DESIGN FOR MANUFACTURING AND ASSEMBLY (21D35106) PE – I	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Introduce design principle, properties of materials, fits and tolerances and datum features
- Understand the influence of materials on form design and able to select possible material and feasible design.
- Introduce design features to facilitate machining and design for match inability, economy, accessibility and assembly.
- Know about redesign of castings, modifying the uneconomical design, group technology and applications of DFMA.
- Understand the Environmental objectives and issues and to design considering them.

Course Outcomes (CO): Student will be able to

- Select the design principle, suitable material, mechanism, fit and tolerance for designing a product/component.
- Select the appropriate material, proper working principle and a feasible design.
- Design (optimum) a component which requires less material removal, easy to machine, assemble, access and cost effective.
- Redesign the uneconomical casting design and know the applications of DFMA.
- Incorporate the Environmental Objectives, issues and guidelines into the design.

UNIT - I	INTRODUCTION	Lecture Hrs:09

Design philosophy steps in Design process - General Design rules for manufacturability -basic principles of design Ling for economical production - creativity in design. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection - Material selection interrelationship with process selection process selection charts, material usage and sustainability.

UNIT - II	MACHINING PROCESS	Lecture Hrs:09

Overview of various machining processes - general design rules for machining -Dimensional tolerance and surface roughness - Design for machining - Ease - Redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.

METALCASTING: Appraisal of various casting processes, selection of casting process, - general designconsiderations for casting - casting tolerances - use of solidification simulation in casting design - product design rules for sand casting.

UNIT - III	JOINING TECHNIQUES	Lecture Hrs:09

METAL JOINING: Appraisal of various welding processes, Factors in design of weldments- general design guidelines - pre and post treatment of welds - effects of thermal stresses in weld joints - design of brazed joints. Forging - Design factors for Forging - Closed dies forging design - parting lines of die5 drop forging die design - general design recommendations. Extrusion & Sheet Metal Work: Design guidelines for extruded sections - design principles for Punching, Blanking, Bending, and Deep Drawing - Keeler Goodman Forming Line Diagram - Component Design for Blanking.

ADHESIVE BONDING: History of adhesive bonding, adhesives and sealants –working, mechanical properties of the joints, testing of the joints and different failure modes, applications of the joints.		
UNIT - IV	**ASSEMBLY ADVANTAGES**	Lecture Hrs:09
Development of the assemble process, choice of assemble method assemble advantages social effects of automation. **Automatic Assembly Transfer Systems**: Continuous transfer, intermittent transfer, indexing mechanisms and operator - paced free – transfer machine.		
UNIT - V	**DESIGN OF MANUAL ASSEMBLY**	Lecture Hrs:09
Design for assembly fits in the design process, general designguidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time.		

Textbooks:

1. Assembly Automation and Product Design/ Geoffrey Boothroyd/ Marcel Dekker Inc., NY, 1992.
2. Engineering Design - Material & Processing Approach/ George E. Deiter/McGraw Hill Intl. 2nd Ed. 2000.

Reference Books:

1. Hand Book of Product Design/ Geoffrey Boothroyd/ Marcel and Dekken, N.Y. 1990.
2. Computer Aided Assembly London/ A Delbainbre/.
3. Product Design for Manufacturing and Assembly/ Geoffrey Boothroyd, Peter Dewhurst & Winston Ansthony Knight/CRC Press/2010
4. Dieter G.E. – Engineering Design –A materials and processing approach.-McGraw Hill - 1991.
5. R.D. Adams , Adhesive Bonding – First edition.

Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc19_me48/preview
2. nptel.ac.in/courses/107/103/107103012/
3. https://www.3ds.com/3dexperience/cloud/dfma-anywhere

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Course Code	21D35107	ADVANCED CAD (21D35107) PE – II	L	T	P	C
Semester	I		3	0	0	3

Course Objectives:

- Model the 3D geometric information of machine components including assemblies, and automatically generate 2- D production drawings, understand the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
- Improve visualization ability of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring.
- Model complex shapes including freeform curves and surfaces,
- Integrate the CAD system and the CAM system by using the CAD system for modelling design Information and converting the CAD model into a CAM model for modelling the manufacturing Information.
- Use full scale CAD/CAM software systems designed for geometric modeling of machine Components and automatic generation of manufacturing information.

Course Outcomes (CO): Student will be able to

- Understand the concepts of wireframe, surface and solid modelling
- Understand part modelling and part data exchange standards (VDA,IGES and STEP)
- Develop knowledge in 2D-Transformations, 3D Transformations.
- Understand the Assembly Modelling, Assembly tree, and Assembly Methods.
- The Students□ become experts on Visualization and computer animation Techniques.

UNIT - I	PRINCIPLES OF COMPUTER GRAPHICS	Lecture Hrs:09

Introduction, graphic primitives, point plotting, lines,Bresenham's circle algorithm, ellipse, transformation in graphics, coordinate systems, view port, 2D and 3D transformation, hidden surface removal, reflection, shading and generation of characters.CAD –modelling of curves, surfaces and solids manipulation of CAD models, features based modelling, product data exchange standards.

UNIT - II	CAD TOOLS & GEOMETRICMODELLING	Lecture Hrs:09

CAD TOOLS: Definition of CAD Tools, Types ofsystemCAD/CAMsystemevaluationcriteria, brieftreatment of input and outputdevices.Graphicsstandard, functionalareas ofCAD, Modeling and viewing, software documentation, efficient use of CAD software.

GEOMETRICMODELLING: Types of mathematical representation of curves, wire frame models wire frameentities parametric representation of synthetic curves her mite cubic splines Bezier curves B-splines rational curves.

UNIT - III	SURFACE MODELING	Lecture Hrs:09

Mathematical representation surfaces, Surface model, Surface entities surfacerepresentation, Parametric representation of surfaces, plane surface, rule surface, surface of revolution, Tabulated Cylinder

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UNIT - IV	**PARAMETRIC REPRESENTATION OF SYNTHETIC SURFACES**	Lecture Hrs:09
HermiteBicubic surface, **Bezier** surface, **B-** Spline surface, COONs surface, Blending surface Sculptured surface, Surface manipulation — Displaying, Segmentation, Trimming, Intersection, Transformations (both 2D and 3D).		
UNIT - V	**GEOMETRICMODELLING**	Lecture Hrs:09
GEOMETRICMODELLING: Solid modelling, Solid Representation, BoundaryRepresentation (13-rep), Constructive Solid Geometry (CSG). **CAD/CAM Exchange** : Evaluation of data - exchange format, IGES data representations and structure,STEP Architecture, implementation, ACIS & DXF. Design Applications: Mechanical tolerances, Mass property calculations, Finite Element Modelling and Analysis and Mechanical Assembly. **Collaborative Engineering:** Collaborative Design, Principles, Approaches, Tools, Design Systems.		
Textbooks:		
1. Mastering CAD/CAM / IbrhimZeid / McGraw Hill International. 2. CAD/CAM Principles and Applications/ P.N.Rao/TMH/3rd Edition		
Reference Books:		
1. CAD/CAM /Groover M.P./ Pearson education 2. CAD/CAM Concepts and Applications/ Alavala/ PHI 3. CAD / CAM / CIM, Radhakrishnan and Subramanian/ New Age 4. Principles of Computer Aided Design and Manufacturing/ FaridAmirouche/ Pearson 5. Computer Numerical Control Concepts and programming/ Warren S Seames/ Thomson		
Online Learning Resources:		
1. https://nptel.ac.in/courses/112/102/112102101/ 2. https://nptel.ac.in/courses/112/102/112102102/ 3. https://www.youtube.com/watch?v=EgKc9L7cbKc 4. https://www.youtube.com/watch?v=0IgOapAtauM		

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35108	ADVANCEDMECHATRONICS (21D35108)	L	T	P	C
Semester	I	PE – II	3	0	0	3

Course Objectives:

For students to Develop skills and confidence to create your own custom microcontroller-based electronics projects via:

- A review basic electronics (e.g., filters, op. amps, transistors.
- Learning to interface electrical peripherals (e.g., A/D, D/A, Sensors, Motors, Timers, Interrupts, Serial Communication) with a microcontroller through focused lab exercises and a term project.
- Knowledge of feature in mechatronics and related technology innovation.

Course Outcomes (CO): Student will be able to

- Select and apply the knowledge, skills and modern tools in mechatronics engineering.
- Apply concepts of circuit analysis, automation and controls, motor, electronic drives, paper systems, instrumentation and trouble shooting and mechatronic systems.

UNIT - I		Lecture Hrs:09

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion , force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT - II		Lecture Hrs:09

Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC.Analog signal conditioning, amplifiers, filtering.Introduction to MEMS & typical applications.

UNIT - III		Lecture Hrs:09

Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.

UNIT - IV		Lecture Hrs:09

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT - V		Lecture Hrs:09

System and interfacing and data acquisition, DAQS , SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.

Textbooks:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran& GK VijayaRaghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

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Reference Books:

1. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
3. Mechatronics System Design / Devdasshetty/Richard/Thomson.
4. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
5. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton
6. Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print

Online Learning Resources:

1. https://nptel.ac.in/courses/112/103/112103174/
2. https://onlinecourses.nptel.ac.in/noc21_me129/preview
3. https://www.zapmeta.ws/ws?q=learn%20mechatronics%20online&asid=ws_gc2_01&mt=b&nw=g&de=c&ap=&ac=2043&cid=12107643587&aid=116602233036&locale=en_US&gclid=Cj0KCQjw8p2MBhCiARIsADDUFVGgBfWYs6C2leVaRqLcALInigZNXhDJGfoXp4kpVGHqWDKZk9nwkzcaAheoEALw_wcB
4. https://studyres.com/doc/2857370/mechatronics-and-manufacturing-automation-nptel

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DEPARTMENT OF MECHANICAL ENGINEERING
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Course Code	21D35109	AUTOMATION LABORATORY (21D35109)	L	T	P	C
Semester	I		0	0	4	2

Course Objectives:

- To train the students in writing programs for robot movements
- To train the students in handling FMS cell for different sequences.
- To design the hydraulic and pneumatic circuits by using automation studio software.
- To design the automated manufacturing systems by using workspace software.

Course Outcomes (CO):

- Demonstrate the pick and place Aristo Robot.
- Demonstrate the working of workspace software.
- Check the circuit designs whether working properly or not by using Automation studio software.

List of Experiments:

1. Aristo XT Six axis Robot
a. Introduction to Robot programming.
b.Robot programming exercises (Point-to-Point and continuous path task).

2. WORKSPACE software.
a. Simulation of a manufacturing system for increasing production rate.
b. Simulation of a simple automation system.

3. AUTOMATION STUDIO software. I.Hydraulic Circuits
a. Introduction to Automation studio & its control.
b. Draw & Simulate the Hydraulic circuit for series & parallel cylinders connection.
c. Draw & Simulate Meter-in, Meter-out and hydraulic press and clamping.
d. Sequencing circuits in hydraulics.
e. Synchronizing circuits in hydraulics.

II. Pneumatic circuits
a. Sequencing circuits in Pneumatics.
b. Synchronizing circuits in Pneumatics.
c. Design and Simulation of simple pneumatic circuit by using Cascade Method.
d. Design and Simulation of simple pneumatic circuit by using step counter method.

4. Additive manufacturing machine
a. Introduction to Additive manufacturingMachine.
b. Design and fabrication of simple symmetrical and unsymmetrical components.

References:

Online learning resources/Virtual labs:

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
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Course Code	21D35110	METAL CUTTING LABORATORY (21D35110)	L	T	P	C
Semester	I		0	0	4	2

Course Objectives: Students able to

- Understand the different machining processes
- Understand the and material technologies
- Study the different cutting operations

Course Outcomes (CO):

- Demonstrate the machining processes
- Check the MRR in different processes

List of Experiments:

1. Study of the morphology of chips produced from different materials sand machining processes.
2. Effect of tool geometry on chip flow direction in simulated orthogonal cutting conditions.
3. Study of cutting ratio/chip thickness ratio in simulated orthogonal cutting with different materials and tool geometry.
4. Evaluations of tool face temperature with thermocouple method.
5. Roughness of machined surface. Influence of tool geometry and feed rate.
6. Extrusion of cylindrical billets through dies of different included angles and exit diameters and their effect on extrusion pressure.
7. Practice and study of blanking and punching process and their characteristic features on mechanical press with existing dies.
8. Study of operation of tool and cutter grinder, twist drill grinder, Centreless grinder
9. Determination of cutting forces in turning
10. Inspection of parts using tool makers microscope, roughness and form tester
11. Experimental Study of MRR on EDM
12. Experimental Study of TWR on EDM
13. Experimental Study of Surface Roughness on EDM
14. Experimental Study on ECM
15. Experimental Study on 3D Printing

References:

Online learning resources/Virtual labs:

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Course Code		**VALUE EDUCATION**	**L**	**T**	**P**	**C**
Semester	**I**	**(Audit Course-I)**	**2**	**0**	**0**	**0**

Course Objectives:

1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Course Outcomes (CO): Student will be able to

UNIT - I		Lecture Hrs:

Values and self-development –Social values and individual attitudes, Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles.,Value judgements

UNIT - II		Lecture Hrs:

Importance of cultivation of values., Sense of duty. Devotion, Self-reliance. Confidence, Concentration, Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity, Patriotism. Love for nature ,Discipline

UNIT - III		Lecture Hrs:

Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour., Universal brotherhood and religious tolerance.

UNIT - IV		Lecture Hrs:

True friendship., Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT - V		Lecture Hrs:

Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

Textbooks:

1 Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Reference Books:

Online Learning Resources:

Course Code		**PEDAGOGY STUDIES**	**L**	**T**	**P**	**C**

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Semester	**I**	**(Audit Course-I)**	**2**	**0**	**0**	**0**

Course Objectives:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes (CO): Student will be able to

1. Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassrooms in developing countries?
2. What istheevidence on the effectiveness of these pedagogical practices, in what conditions, and with what population oflearners?
3. Howcanteachereducation(curriculumandpracticum)andtheschoolcurriculumand guidancematerials best support effectivepedagogy?

UNIT - I		Lecture Hrs:

Introduction and Methodology, Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT - II		Lecture Hrs:

Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.

UNIT - III		Lecture Hrs:

Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school, curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical, practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT - IV		Lecture Hrs:

Professional development: alignment with classroom practices and followupsupport Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes

UNIT - V		Lecture Hrs:

Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.

Textbooks:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.

Reference Books:
1. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282. 2. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell. 3. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
OnlineLearningResources:www.pratham.org/images/resource%20working%20paper%202.pdf.

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35201	Simulation of Manufacturing Systems (21D35201)	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- To provide knowledge simulation and simulation steps
- To provide knowledge on parameter estimation and hypothesis
- To provide knowledge on building simulation model how to validation and verification is done
- To provide knowledge on generation of random variants and variables
- To provide knowledge on some simulation languages
- To provide knowledge on some Applications of Simulation

Course Outcomes (CO): Student will be able to

- Students gain knowledge on various types of simulation and simulation languages steps in simulation and applications of simulation.
- Students gain knowledge on parameter estimation and hypothesis.
- Students can build simulation model and also can validation and verify model.
- Can Generation of random variants and variables.

UNIT - I		Lecture Hrs:09

System - ways to analyze the system - Model - types of models - Simulation - Definition - Types of simulation models - steps involved in simulation - Advantages & Disadvantages. Parameter estimation - estimator - properties - estimate - point estimate - confidence interval estimates - independent - dependent - hypothesis - types of hypothesis- step - types l& 2 errors - Framing - string law of large numbers.

UNIT - II		Lecture Hrs:09

Building of Simulation model validation - verification - credibility - their timing - principles of valid simulation Modeling - Techniques for verification - statistical procedures for developing credible model.Modeling of stochastic input elements - importance - various procedures - theoretical distribution - continuous - discrete their suitability in modeling.

UNIT - III		Lecture Hrs:09

Generation of random variables - factors for selection methods - inverse transform - composition - convolution - acceptance - rejection - generation of random variables - exponential - uniform - weibull - normal Bernoullie - Binomial uniform - poisson - Simulation languages - comparison of simulation languages with general purpose languages Simulation languages vs Simulators - software features - statistical capabilities - G P S S - S1MAN- SIMSCRIPT - Simulation of WMJI queue - comparison of simulation languages.

UNIT - IV		Lecture Hrs:09

Output data analysis - Types of Simulation w. r. t output data analysis – warm up period- Welch algorithm - Approaches for Steady - State Analysis - replication - Batch means methods - corn pan Sons.

UNIT - V		Lecture Hrs:09

Applications of Simulation - flow shop system - job shop system - M/MI1 queues with infinite and finite capacities - Simple fixed period inventory system – New boy paper problem.

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Textbooks:
1. Simulation Modelling and Analysis / Law, A.M.&Kelton / McGraw Hill, Edition/ New York, 1991. 2. Discrete Event System Simulation *I* Banks J. & Carson J.S., PH *I* Englewood Cliffs N/ 1984.
Reference Books:
1. Simulation of Manufacturing Systems / Carrie A. / Wiley, NY, 1990. 2. A Course in Simulation / Ross, S.M., McMillan, NY, 1990. 3. Simulation Modelling and S1MNET/ Taha HA. / PH, Englewood Cliffs, NJ, 1987
Online Learning Resources:
1. https://nptel.ac.in/courses/112/107/112107220/ 2. https://www.youtube.com/watch?v=wbLItIE-78E 3. https://www.youtube.com/watch?v=tiarT1YS-lM

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DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35202	Quality Engineering in Manufacturing (21D35202)	L	T	P	C
Semester	II		3	0	0	3

Course Objectives:

- Explore knowledge of basic sciences engineering and manufacturing process.
- Manage projects in various sectors of economy which facing on conceptual, technological and human aspects.
- Identify the bottle ends and production process.
- Similarity of the manufacturing process to analyze the overall performance

Course Outcomes (CO): Student will be able to

- Applications of the user friendly software packages to simulate the manufacturing entities.
- Analyze the data by using different performance analysis techniques.
- Modelling various operators in manufacturing systems

UNIT - I	QUALITY VALUE AND ENGINEERING	Lecture Hrs:09

An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances.(N-type,S-type and L-type)

UNIT - II	TOLERANCE DESIGN AND TOLERANCING	Lecture Hrs:09

Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation fbr multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.

UNIT - III	ANALYSIS OF VARIANCE (ANOVA)	Lecture Hrs:09

Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT - IV	ORTHOGONAL ARRAYS	Lecture Hrs:09

Typical test strategies, better test strategies, efficient test strategies, steps indesigning, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean.

UNIT - V	SIX SIGMA AND THE TECHNICAL SYSTEM	Lecture Hrs:09

Six sigma DMAIC methodology, tools for process improvement, six sigma in services and small organizations,statistical foundations, statistical methodology.

Textbooks:

1. Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995.
2. Quality Engineering in Production systems *I* G. Taguchi, A. Elsayed et al /Mc.Graw Hill Intl. Edition, 1989**.**

Reference Books:

1. Taguchi Methods explained: Practical steps to Robust Design /Papan P. Bagchi*I*Prentice Hall Pvt. Ltd., New Delhi.

Online Learning Resources:

1. https://nptel.ac.in/courses/112/107/112107259/

2. https://onlinecourses.nptel.ac.in/noc20_me27/preview
3. https://nptel.ac.in/noc/courses/noc20/SEM1/noc20-me27/
4. https://nptel.ac.in/courses/110/101/110101010/
5. https://onlinecourses.nptel.ac.in/noc20_mg18/preview

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35203	MATERIAL SCIENCE & TECHNOLOGY (21D35203)	L	T	P	C
Semester	II	PE – III	3	0	0	3

Course Objectives:

- To gain and understanding of the relationship between the structure, properties, processing, testing and applications of strengthening mechanism, modern metallic, smart, non-metallic, advanced structural ceramic and composite materials so as to identify and select suitable materials for various engineering applications.

Course Outcomes (CO): Student will be able to

- Students will get knowledge on mechanism of plastic deformation andstrengthening mechanism. Students will be able to learn the structure, properties and applications of modern metallic materials, smart materials non-metallic materials and advanced structural ceramics. Students will be able to understand the importance of advanced composite materials in application to sophisticated machine and structure of components.

UNIT - I — Lecture Hrs:09

Elasticity in metals and polymers, mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, deformation of non-crystalline material.

UNIT - II — Lecture Hrs:09

Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps.

UNIT - III — Lecture Hrs:09

Fatigue, Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis.

MODELING AND SIMULATION IN MATERIALS ENGINEERING:
Importance of modeling and simulation in materials engineering and numerical approaches, Numerical solutions of ODEs and PDEs, implicit methods, simple models for simulating microstructures, FE modeling of 1D, variation approach.

UNIT - IV — Lecture Hrs:09

Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep. Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing, Case studies in Materials Selection with relevance to Aero, Auto , Marine, Machinery and Nuclear Applications.

UNIT - V — Lecture Hrs:09

MODERN METALLIC MATERIALS: Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel,Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides, Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials.

NONMETALLIC MATERIALS: Polymeric materials and their molecular structures,

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Production Techniquesfor Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, A12 O3, SiC, Si3 N4, CBN and Diamond – properties, Processing and applications.
Textbooks:
1. Mechanical Behavior of Materials/Thomas H. Courtney/ McGraw Hill/2 nd Edition/2000 2. Mechanical Metallurgy/George E. Dicter/McGraw Hill, 1998.
Reference Books:
1. Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann. 2. Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson 3. Material Science and Engineering/William D Callister/John Wiley and Sons
Online Learning Resources:
1. https://nptel.ac.in/courses/113/106/113106032/ 2. https://nptel.ac.in/courses/113/107/113107078/ 3. https://www.digimat.in/nptel/courses/video/113107078/L01.html

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DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35204	INDUSTRIAL ROBOTICS (21D35204)	L	T	P	C
Semester	II	PE – III	3	0	0	3

Course Objectives:

- To be familiar with the automation and brief history of robot and applications
- To give the student familiarities with the kinematics of robots.
- To give knowledge about robot end effectors and their design.
- To learn about Robot Programming methods & Languages of robot
- To give knowledge about various Sensors and their applications in robots.

Course Outcomes (CO): Student will be able to

- Students will be equipped with the automation and brief history of robot and applications
- Students will be familiarized with the kinematic motions of robot
- Students will have good knowledge about robot end effectors and their design concepts.
- Students will be equipped with the Programming methods & various Languages of robots.
- Students will be equipped with the principles of various Sensors and their applications in robots

UNIT - I	INTRODUCTION	Lecture Hrs:09

INTRODUCTION: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation work volume, robot drive system, control system and dynamic performance, precision of movement.

CONTROL SYSTEM AND COMPONENTS: basic concept and modais controllers control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system

UNIT - II	MOTION ANALYSIS AND CONTROL	Lecture Hrs:09

Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller.

UNIT - III	END EFFECTORS	Lecture Hrs:09

Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics.

MACHINE VISION: Functions, Sensing and Digitizing-imaging, Devices, Lighting techniques, Analog to digital single conversion, image storage, Image processing and Analysis-image data reduction, Segmentation feature extraction. Object recognition, training the vision system, Robotics application.

UNIT - IV	ROBOT PROGRAMMING	Lecture Hrs:09

Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINONAL AND DELAY commands, Branching capabilities and Limitations.

ROBOT LANGUAGES: Textual robot Languages, Generation, Robot language structures, Elements in function.

UNIT - V	ROBOT CELL DESGIN AND CONTROL	Lecture Hrs:09

Robot cell layouts-Robot cantered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detect ion, Work wheel controller.

ROBOT APPLICATION: Material transfer, Machine loading/unloading. Processing

operation, Assembly and Inspection, Feature Application
Textbooks:
1. Industrial Robotics / Groover M P /Pearson Edu. 2. Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition
Reference Books:
1. Robotics / Fu K S/ McGraw Hill. 2. Robotic Engineering / Richard D. Klafter, Prentice Hall 3. Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science. 4. Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley & Sons (ASIA) Pte Ltd. 5. Robotics and Control / Mittal R K &Nagrath I J / TMH
Online Learning Resources:
1. https://nptel.ac.in/courses/112/105/112105249/ 2. https://nptel.ac.in/content/storage2/courses/112101098/download/lecture-3.pdf 3. https://onlinecourses.nptel.ac.in/noc19_me74/preview

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Course Code	21D35205	ADVANCED TOOL DESIGN (21D35205)	L	T	P	C
Semester	II	PE – III	3	0	0	3

Course Objectives:

- To describe tool design methods and punch and die making/manufacturing techniques.
- To understand the principles of clamping, drill jigs.
- To understand the principles of dies and molds design

Course Outcomes (CO): Student will be able to

- Students will be familiar with cutting tools and cutting fluids, machine tools, metal forming, etc.
- Applications of different techniques learned above in the real world.

UNIT - I	TOOL MATERIALS:	Lecture Hrs:09

Prosperities of materials: Tools steels, Cast Iron, Mild or low carbon steels, Non metallic and nonferrous materials, Heat treating

UNIT - II	DESIGN OF CUTTING TOOLS:	Lecture Hrs:09

Single Point cutting tools: Milling cutters, Drills, Selection of carbide steels – Determination of shank size for single point carbide tools, Determining the insert thickness for carbide tools.

UNIT - III	DESIGN OF JIGS AND FIXTURES	Lecture Hrs:09

Basic principles of location and clamping: Locating methods and devices, Jigs-Definition Types, General considerations in the design of Drill jigs, Drill bushing, Methods of Construction. Fixtures-Vice fixtures, Milling, Boring Lathe Grinding fixtures.

UNIT - IV	DESIGN OF SHEET METAL BLANKING AND PIERCING DIES	Lecture Hrs:09

Fundamentals of Die cutting operation, Power press types, General press information, Materials Handling equipment. Cutting action in Punch and die operations. Die clearance, Types of Die construction. Die design fundamentals-Banking and piercing die construction, pilots, stripper and pressure pads presswork material, Strip layout, Short run tooling for piercing.

UNIT - V	DESIGN OF SHEET METAL BENDING, FORMING AND DRAWING DIES:	Lecture Hrs:09

Bending dies, Drawing dies, Forming dies, Drawing operations, Variables that effect metal flow during drawing. Determination of blank size, Drawing force, Single and double action draw dies.

Textbooks:

1. Donaldson “Tool Design”/ Tata McGraw Hill
2. Production Technology/HMT/Tata McGraw Hill/

Reference Books:

1. Production Technology by R.K. Jain and S.C. Gupta.
1. 2 Mechanical Metallurgy/ George F Dieter/ Tata McGraw Hill
2. Machine Tools/C Elanchezhian& M. Vijayan/Anuradha Publications
3. Principles of Machine Tools, Bhattacharya A and Sen.G.C. New Central Book Agency
4. Hand Book of Metal forming/ Kurt Lange/ Mc Graw-Hill,.1987

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Online Learning Resources:
1. https://nptel.ac.in/courses/112/105/112105233/ 2. https://nptel.ac.in/courses/112/107/112107078/

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35206	Production & Operations Management (21D35206)	L	T	P	C
Semester	II	PE – IV	3	0	0	3

Course Objectives:

- The objective is to introduce concepts and techniques related to the design, planning, control and improvement of businesses in both manufacturing and service sectors.
- This course aims at developing a focus and critical thinking important to solve problems in the operations of business. The students will be required to understand and apply the tools of management learned in the course to practical situations.
- To produce the desired product this has marketability at the most affordable price by properly planning the manpower, material and processes.
- To achieve the objective of delivering the right goods of right quantity as well as quality, at right place and at right time one needs to understand and apply the concepts of Production and operations management.
- Efficient Advanced Production and operations management, give benefits to various sections including consumers, investors, employees, suppliers and community in different ways.

Course Outcomes (CO): Student will be able to

- Understand the principles of production and operations Management
- Understand the operations process, be able to analyze and solve problems pertaining to operations.
- Understand some of the mathematical models of production management.
- Appraise how other functional areas of business are integrated with Operations Management.

UNIT - I	OPERATION MANAGEMENT	Lecture Hrs:09

Definition – Objectives – Types of production systems – historical development of operations management – Current issues in operation management.
Product design – Requirements of good product design – product development – approaches – concepts in product development – standardization – simplification – Speed to market – Introduction to concurrent engineering.

UNIT - II	VALUE ENGINEERING	Lecture Hrs:09

Objective – types of values – function & cost – product life cycle- steps in value engineering – methodology in value engineers – FAST Diagram – Matrix Method.
Location – Facility location and layout – Factors considerations in Plant location- Comparative Study of rural and urban sites – Methods of selection plant layout – objective of good layout – Principles – Types of layout– line balancing.

UNIT - III	AGGREGATE PLANNING	Lecture Hrs:09

Definition – Different Strategies – Various models of Aggregate Planning –Transportation and graphical models.
Advance inventory control systems push systems – Material Requirement – Terminology – types of demands – inputs to MRP- techniques of MRP – Lot sizing methods – benefits and drawbacks of MRP – Manufacturing Resources Planning (MRP –II), Pull systems – Vs Push system – Just in time (JIT) philosophy Kanban System – Calculation of number

of Kanbans Requirements for implementation JIT – JIT Production process – benefits of JIT.		
UNIT - IV	**SCHEDULING**	Lecture Hrs:09
Policies – Types of scheduling – Forward and Backward Scheduling – Gantt Charts – Flowshop Scheduling – n jobs and 2 machines, n jobs and 3 machines – job shop Scheduling – 2 jobs and n machines – Line of Balance.		
UNIT - V	**PROJECT MANAGEMENT**	Lecture Hrs:09
Programming Evaluation Review Techniques (PERT) – three times estimation – critical path – probability of completion of project – critical path method – crashing of simple nature.		

Textbooks:

1. Operations Management/ E.S. Buffs/ John Wiley & Sons / 2007
2. Operations Management Theory and Problems/ Joseph G. Monks / Macmillan / McGraw Hill / 3rd Edition.

Reference Books:

1. Production Systems Management/ James I. Riggs / John Wiley & Sons.
2. Production and Operations Management/ Chary/ McGraw Hill/2004
3. Operations Management/ Richard Chase/ McGraw Hill/2006
4. Production and Operation Management / PannerSelvam / PHI.
5. Production and Operation Analysis/ Nahima/ McGraw Hill/2004

Online Learning Resources:

1. https://nptel.ac.in/courses/110/107/110107141/
2. https://nptel.ac.in/courses/111/107/111107128/
3. https://nptel.ac.in/courses/112/106/112106131/
4. https://nptel.ac.in/courses/112/106/112106134/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35207	Modelling of Manufacturing Systems (21D35207)	L	T	P	C
Semester	II	PE – IV	3	0	0	3

Course Objectives:

- To impart the basic ideas to enable the modelling, simulation and analysis of advanced manufacturing systems

Course Outcomes (CO): Student will be able to

- Students are expected to learn how to formulate and solve computational problems analysis in the flow of fluids.
- Familiar with the differential equations for flow phenomena and numerical methods for their solutions.

UNIT – I	MANUFACTURING SYSTEMS & CONTROL	Lecture Hrs:09

Automated Manufacturing Systems – Modeling – Role of performance modeling – simulation models-Analytical models.Product cycle – Manufacturing automation – Economics of scale and scope – input/output model – plant configurations. Performance measures – Manufacturing lead time – Work in process – Machine utilization – Throughput – Capacity – Flexibility – Performability – Quality Control Systems – Control system architecture – Factory communications – Local area network interconnections – Manufacturing automation protocol – Database management system.

UNIT – II	MANUFACTURING PROCESSES:	Lecture Hrs:09

Examples of stochastics processes – Poisson process - Discrete time Markov chain models – Definition and notation – Sojourn times in states – Examples of DTMCs in manufacturing – Chapman – Kolmogorov equation – Steady-state analysis. Continuous Time Markov Chain Models – Definitions and notation – Sojourn times in states – examples of CTMCs in manufacturing – Equations for CTMC evolution – Markov model of a transfer line Birth and Death Processes in Manufacturing – Steady state analysis of BD Processes – Typical BD processes in manufacturing.

UNIT – III	QUEUING MODEL	Lecture Hrs:09

Notation for queues – Examples of queues in manufacturing systems – Performance measures – Little's result – Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns – Analysis of a flexible machine center.

UNIT – IV	QUEUING NETWORKS	Lecture Hrs:09

Examples of QN models in manufacturing – Little's law in queuing networks – Tandem queue – An open queuing network with feedback – An open central server model for FMS – Closed transfer line – Closed server model – Garden Newell networks.

UNIT – V	PETRINETS	Lecture Hrs:09

Classical Petri Nets – Definitions – Transition firing and reachability – Representational power – properties – Manufacturing models.
Stochastic Petri Nets – Exponential timed Petri Nets – Generalized Stochastic Petri Nets – modeling of KANBAN systems – Manufacturing models.

Textbooks:

1. Performance Modelling of Automated Manufacturing Systems/ Viswanadham, N and Narahari, Y/ Prentice Hall of India, New Delhi, 1994

2. Probability and Statistics with Reliability, Queuing and Computer Science Applications/ Trivedi, K.S./ Prentice Hall, New Jersey, 1982.
Reference Books:
1. Fundamentals of Mathematical Statistics/ Gupta S.C. &Kapoor V.K./ 3rd Edition, Delhi, 1988
Online Learning Resources:
1. https://nptel.ac.in/courses/112/107/112107220/ 2. https://nptel.ac.in/courses/110/106/110106044/ 3. https://nptel.ac.in/courses/112/103/112103273/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35208	OPTIMIZATION TECHNIQUES (21D35208)	L	T	P	C
Semester	II	PE – IV	3	0	0	3

Course Objectives:

- To introduce the advanced optimization techniques such as classical optimization techniques, numerical optimization techniques and genetic algorithms.
- Learn the knowledge to formulate optimization problems

Course Outcomes (CO): Student will be able to

- Students at the end of the course learn advanced optimization techniques to show real-life problems
- Students can able to formulate and solve various practical optimization problems in manufacturing and service organizations

UNIT - I	CLASSICAL OPTIMIZATION TECHNIQUES	Lecture Hrs:09

Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.

UNIT - II	NUMERICAL METHODS FOR OPTIMIZATION	Lecture Hrs:09

Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.

UNIT - III	GENETIC ALGORITHM (GA)	Lecture Hrs:09

Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA.

Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems

UNIT - IV	GENETIC PROGRAMMING (GP)	Lecture Hrs:09

Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.

UNIT - V	APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS	Lecture Hrs:09

Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam and general optimization model of a machining process.

Textbooks:

1. Optimal design – JasbirArora, McGraw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers

Reference Books:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Genetic Programming- Koza
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers

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DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Online Learning Resources:
1. nptel.ac.in/courses/105/108/105108127/ 2. nptel.ac.in/courses/111/105/111105100/ 3. nptel.ac.in/courses/111/104/111104071/ 4. nptel.ac.in/content/storage2/courses/105108127/pdf/Module_8/M8L5_LN.pdf 5. nptel.ac.in/content/storage2/courses/105108127/pdf/Module_8/M8L5slides.pdf

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35209	MANUFACTURING SIMULATION LABORATORY (21D35209)	L	T	P	C
Semester	II		0	0	4	2

Course Objectives:

- To understand the various manufacturing processes
- To understand the various Simulation Processes

Course Outcomes (CO):

- To learn various softwares to design.

LIST OF EXPERIMENTS:

A. Manufacturing Simulation

The students will be given training on the use and application of the following software to manufacturing problems:

1. Auto MOD Software.
2. PROMODEL
3. SLAM-II
4. CAFIMS
5. Flexsim

They also learn how to write sub routines in C-language and interlinking with the above packages. Problems for modelling and simulation experiments:

1. AGV planning
2. ASRS simulation and performance evaluation
3. Machines, AGVs and AS/RS integrated problems
4. JIT system
5. Kanban flow
6. Material handling systems
7. M.R.P. Problems
8. Shop floor scheduling etc.

B. Precision Engineering

1. Hydraulic and Pneumatic circuits
2. Closed loop control systems
3. Study of the chip formation in turning process
4. Study of operation of tool and cutter grinder, twist drill grinder, Centreless grinder
5. Determination of cutting forces in turning
6. Experiments in unconventional manufacturing processes-AJM and study of USM, EDM, Laser Machining and Plasma spraying
7. Inspection of parts using tool makers microscope, roughness and form tester
8. Study of micro-controllers, programming on various CNC machine tools and also controllers
9. Studies on PLC programming
10. Study and programming of robots
11. Condition monitoring in machining process using acoustic emission.

References:

Online learning resources/Virtual labs:

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35210	ADVANCED CAD/CAM LABORATORY (21D35210)	L	T	P	C
Semester	II		0	0	4	2

Course Objectives:

- Model the 3D geometric information of machine components including assemblies, and automatically generate 2D production drawings, understand the basic analytical fundamentals that are used to create and manipulate geometric models in a computer program.
- Improve visualization ability of machine components and assemblies before their actual fabrication through modeling, animation, shading, rendering, lighting and coloring.
- Model complex shapes including freeform curves and surfaces,
- Integrate the CAD system and the CAM system by using the CAD system for modeling design Information and converting the CAD model into a CAM model for modeling the manufacturing Information.
- Use full scale CAD/CAM software systems designed for geometric modeling of machine Components and automatic generation of manufacturing information

Course Outcomes (CO):

- Understand the concepts of wire frame, surface and modeling
- Understand part modeling and part data exchange standards (VDA,IGES and STEP)
- Develop knowledge in 2D-Transformations, 3D Transformations.
- Understand the Assembly Modeling, Assembly tree, and Assembly Methods.
- The Students become experts on Visualization and computer animation Techniques.

LIST OF EXPERIMENTS:

1. Features and selection of CNC turning and milling centers.
2. Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles.
3. Practice in part programming and operating a machining center, tool panning and selection of sequences of operations, tool setting on machine, practice in APT based NC programming.
4. Practice in Robot programming and its languages.
5. Robotic simulation using software. Robo path control, preparation of various reports and route sheets, Simulation of manufacturing system using CAM software, controller operating system commands

References:

Online learning resources/Virtual labs:

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Semester-III

Course Code		**Program Elective Course – V**	**L**	**T**	**P**	**C**
Semester	**III**	**a. Total Quality Management**	**3**	**0**	**0**	**3**

Course Objectives:

- Implement the□□ principles and concepts inherent in a Total Quality Management (TQM)
- approach to managing a manufacturing or service organization.
- Explain the system of documentation, implementation and assessment of quality
- Assess exactly where an organization stands on quality management with respect to the ISO 9000 quality management standard.
- Develop a strategy for implementing TQM in an organization

Course Outcomes (CO): Student will be able to

- Develop an understanding on quality management philosophies and framework
- Develop in-depth knowledge on various tools and techniques of quality management.
- Learn the applications of quality tools and techniques.
- Develop analytical skills for investigating and analyzing quality management issues in the industry and suggest implement able solutions to those.

UNIT - I	**INTRODUCTION**	Lecture Hrs:09

The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT - II	**CUSTOMER FOCUS AND SATISFACTION**	Lecture Hrs:09

The importance of customer satisfaction and loyalty- Cratingsatisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT - III	**ORGANIZING FOR TQM**	Lecture Hrs:09

The systems approach, Organizing for quality implementation, making thetransition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

UNIT - IV	**THE COST OF QUALITY**	Lecture Hrs:09

Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use ofQuality Cost Information, Accounting Systems and Quality Management.

UNIT - V	**ISO9000**	Lecture Hrs:09

Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-90. Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system.

Textbooks:

1. Total Quality Management / Joel E.Ross/Taylor and Franscis Limited
2. Total Quality Management/P.N.Mukherjee/PHI

Reference Books:

3. Beyond TQM / Robert L.Flood
4. Statistical Quality Control / E.L. Grant / McGraw Hill.
5. Total Quality Management- A Practical Approach/H. Lal
6. Quality Management/KanishkaBedi/Oxford University Press/2011
7. Total Engineering Quality Management/Sunil Sharma/Macmillan

Online Learning Resources:

1. https://nptel.ac.in/courses/110/104/110104080/
2. https://onlinecourses.nptel.ac.in/noc21_mg03/preview
3. https://nptel.ac.in/courses/110/104/110104085/
4. https://nptel.ac.in/content/syllabus_pdf/110104080.pdf

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code		**Program Elective Course – V**	**L**	**T**	**P**	**C**
Semester	**III**	**b. Theory of Elasticity and Plasticity**	**3**	**0**	**0**	**3**

Course Objectives:

- To impart knowledge of engineering application of plasticity.
- To know the classical theory of elasticity.
- To recognize typical plastic yield criteria.

Course Outcomes (CO): Student will be able to

- To understand the physical interpretation of material constraints in mathematical formulation of constitutive relationships.
- Solve analytically the simple boundary value problems with elasto-plastic properties.
- Develop constitutive models based on experimental results.

UNIT - I	**ELASTICITY**	Lecture Hrs:

Two dimensional stress analysis - Plane stress - Plane strain - Equations of compatibility - Stress function - Boundary conditions.
PROBLEM IN RECTANGULAR COORDINATES - Solution by polynomials - Saint Venent's principles -Determination of displacement - Simple beam problems.
PROBLEMS IN POLAR COORDINATES - General equations in polar coordinates - Stress distribution symmetrical about axis - Strain components in polar coordinates - Simple and symmetric problems.

UNIT - II	**ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS**	Lecture Hrs:09

Principle stresses – Homogeneous deformations - Strain spherical and deviatoric stress - Hydrostatic strain.
General theorems: Differential equations of equilibrium and compatibility - Displacement - Uniqueness of solution - Reciprocal theorem.

UNIT - III	**BENDING OF PRISMATIC BARS**	Lecture Hrs:09

Stress function - Bending of cantilever beam - Beam of rectangular cross-section - Beams of circular cross-section.

UNIT - IV	**PLASTICITY**	Lecture Hrs:09

Plastic deformation of metals - Structure of metals - Deformation - Creep stress relaxation of deformation - Strain rate condition of constant maximum shear stress - Condition of constant strain energy - Approximate equation of plasticity.

UNIT - V	**METHODS OF SOLVING PRACTICAL PROBLEMS:**	Lecture Hrs:09

The characteristic method - Engineering method -Compression of metal under press - Theoretical and experimental data drawing.
Textbooks:
1. Theory of Elasticity/Timoshenko S.P. and Goodier J.N./Koakusha Publishers 2. An Engineering Theory of Plasticity/E.P. Unksov/Butterworths
Reference Books:
3. Applied Elasticity/W.T. Wang/TMH 4. Theory of Plasticity for Engineers/Hoffman and Sacks/TMH 5. Theory of Elasticity and Plasticity/Sadhu Singh/ Khanna Publishers 6. Theory of Elasticity and Plasticity/Harold Malcolm Westergaard/Harvard University Press
Online Learning Resources: **1.** https://onlinecourses.nptel.ac.in/noc20_ce42/preview **2.** https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-ce18/ **3.** https://www.cet.edu.in/noticefiles/260_Lecturer%20Notes%20on%20AEP-ilovepdf-compressed.pdf **4.** https://easyengineering.net/theory-of-elasticity-and-plasticity-by-jane-helena/

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R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
DEPARTMENT OF MECHANICAL ENGINEERING
(ADVANCED MANUFACTURING SYSTEMS)

Course Code	21D35303	DESIGN AND MANUFACTURING OF MEMS AND MICRO SYSTEMS	L	T	P	C
Semester	III	(PE - V)	3	0	0	3

Course Objectives:

1. To learn about electrochemical design and packaging of micro devices and system
2. To learn of the basic design principles for MEMS and Microsystems
3. To learn the basic principles of micro fabrication technique s for micro devices and micro systems, as well as integrated circuits.
4. To learn the basic principles involved in micro systems packaging
5. To learn the basic principle of nano technology and nano scale engineering analysis

Course Outcomes (CO): Student will be able to

1. To be able to explain what micro systems
2. To explain the working principles of many MEMS and micro systems in the market place
3. To understand the relevant engineering science topics relating to MEMS and micro systems.
4. To be able to distinguish the design, manufacture and packaging techniques applicable to micro systems from those for integrated circuits.
5. To become familiar with the materials, in particular, silicon and its compounds for MEMS.
6. To be able to explain the basic and relevant design principles of MEMS and micro systems.
7. To learn the scaling laws for miniaturization.
8. To be able to identify the optimal micro fabrication and packaging techniques for micro devices and systems.
9. To be able to handle mechanical systems engineering design of micro scale devices.
10. To learn the fundamentals of nanotechnology.

UNIT-I	OVERVIEW AND WORKING PRINCIPLES OF MEMS AND MICROSYSTEMS	Lecture Hrs:09

MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & Miniaturization, Applications of MEMS in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidies.

UNIT - II	ENGINEERING SCIENCE FOR MICROSYSTEMS DESIGN AND FABRICATION	Lecture Hrs:09

Atomic structure of Matter, Ions and Ionization, Molecular Theory of Mater and Intermolecular Force, Doping of Semiconductors, The diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics

UNIT-III	ENGINEERING MECHANICS FOR MICROSYSTEMS DESIGN:	Lecture Hrs:09

Static Bending of thin Plates, Mechanical Vibration, Thermo mechanics Fracture Mechanics, Thin-Film Mechanics, Overview of Finite Element Stress Analysis

UNIT-IV	THERMO FLUID ENGINEERING & MICROSYSTEMS DESIGN	Lecture Hrs:09

Overview of Basics of Fluid Mechanics in Macro and Meso scales, Basic equations in Continuum Fluid dynamics, Laminar Fluid Flow in Circular Conduits, Computational Fluid Dynamics, Incompressible Fluid Flow in Micro conduits, Fluid Flow in Sub micro-meter and Nano scale, Overview of Heat conduction in Solids, Heat Conduction in Multi-layered Thin films and in solids in sub micro-meter scale, Design Considerations, Process Design Mechanical

Design, Mechanical Design using FEM, Design of a Silicon Die for a Micro pressure Sensor		
UNIT - V	**MATERIALS FOR MEMS & MICROSYSTEMS AND THEIR FABRICATION**	**Lecture Hrs:09**
Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon Compounds, Silicon Piezo-resistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers, Photolithography, Ion implantation, Diffusion and oxidation, chemical and physical vapor deposition, Etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process		

Textbooks:

1. MEMs & Microsystems: Design & Manufacture/ Tai-Ran Hsu/Tata Mc-Graw Hill., ed./2002
2. An Introduction to Micro electromechanical Systems Engineering/ Maluf, M./ Artech House, Boston, 2000

Reference Books:

1. Micro robots and Micromechanical Systems/ Trimmer, W.S.N/ Sensors & Actuators, vol19, no.1989.
2. Applied Partial Differential Equations/ Trim, D.W/ PWS-Kent Publishing/ Boston 1990.
3. Fundamentals of Micro fabrication. Madou, M/ CRC Press, Boca Raton, 1997.
4. The Finite Element Method in Thermo-mechanics/ Hsu, T.R / Alien &Unwin, London

Online Learning Resources:

1. https://nptel.ac.in/courses/117/105/117105082/
2. https://nptel.ac.in/courses/112/107/112107298/
3. https://nptel.ac.in/courses/112/103/112103174/
4. https://www.youtube.com/watch?v=gzgMWRIl-Fg
5. https://www.youtube.com/watch?v=27GSZFjk1ZQ
6. https://www.youtube.com/watch?v=hCGaiFgmkfg
7. https://www.youtube.com/watch?v=j9y0gfN9WMg

R21 COURSE STRUCTURE &SYLLABUS FOR M.TECH COURSES
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(ADVANCED MANUFACTURING SYSTEMS)

Course Code		Open Elective	L	T	P	C
Semester	III	Mechatronics	3	0	0	3

Course Objectives:

To impart knowledge on

To impart knowledge on about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

Course Outcomes (CO): Student will be able to

1.Students can able to understand the concepts,need and importance of mechatronics.
2. They can able to know the concepts of 8085 microprocessor, 8051 microcontroller
3. They can able to understand the Programmable peripheral Interface
4. Students can able to know the structure, programming and selection of PLC
5. They can able to know the working principle and design concepts of actuators, mechatronic system.

UNIT – I	Lecture Hrs:

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors.

UNIT – II	Lecture Hrs:

8085 MICROPROCESSOR AND 8051 MICROCONTROLLER
Introduction – Architecture of 8085– Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram,.

UNIT – III	Lecture Hrs:

PROGRAMMABLE PERIPHERAL INTERFACE
Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT – IV	Lecture Hrs:

PROGRAMMABLE LOGIC CONTROLLER
Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT – V	Lecture Hrs:

ACTUATORS AND MECHATRONIC SYSTEM DESIGN
Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

Textbooks:

1.Bolton, “Mechatronics”, Printice Hall, 2008 2. Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, 5th Edition, Prentice

Hall, 2008.

Reference Books:

1. Michael B.Histand and Davis G.Alciatore, "Introduction to Mechatronics and Measurement systems", McGraw Hill International edition,2007.
2. Bradley D.A, Dawson D, Buru N.C and Loader A.J, "Mechatronics", Chapman and Hall, 1993.
3. Smaili.A and Mrad.F , "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press,2007.
4. DevadasShetty and Richard A. Kolk, "Mechatronics Systems Design", PWS publishing company,2007.
5. Krishna Kant, "Microprocessors & Microcontrollers", Prentice Hall of India,2007.
6. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print,2013

Online Learning Resources:

https://nptel.ac.in › courses › noc21 › SEM1 › noc21-me27