JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
(Established by Govt. of A.P., ACT No.30 of 2008)
ANANTHAPURAMU – 515 002 (A.P) INDIA

M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

SEMESTER – I

S. No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21D04101	Advanced Finite Element Methods	PC	3	0	0	3
2.	21D04103a	Advances in Manufacturing Technology	PC	3	0	0	3
3.	21DBS101 21D04301b 21D90101	**Program Elective Course - I** Computational methods Design For Manufacturing Rapid Prototyping	PE	3	0	0	3
	21D04201 21D15203a 21D90102	**Program Elective Course – II** Advanced Optimization Techniques Mechanical Vibrations Geometrical Dimensioning and Tolerances	PE	3	0	0	3
5.	21D90103	Design Simulation Laboratory	PC	0	0	4	2
6.	21D90104	Advanced Manufacturing Processes & Metal Cutting Lab	PC	0	0	4	2
7.	21DRM101	Research Methodology and IPR	MC	2	0	0	2
8.	21DAC101a 21DAC101b 21DAC101c	**Audit Course – I** English for Research paper writing Disaster Management Sanskrit for Technical Knowledge	AC	2	0	0	0
Total							**18**

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SEMESTER – II

S.No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1	21D90201	Simulation of Manufacturing Systems	PC	3	0	0	3
2	21D87101	Automation in Manufacturing	PC	3	0	0	3
3		**Program Elective Course – III**	PE	3	0	0	3
	21D87203b	Industrial Robotics					
	21D04203b	Computer Graphics					
	21D87203a	Material science and Technology					
4		**Program Elective Course – IV**	PE	3	0	0	3
	21D90202a	Mechanics & Manufacturing Methods of Composites					
	21D90202b	Advanced Kinematics of Mechanisms					
	21D90202c	Advanced Metal Forming Processes					
5	21D90203	Manufacturing Simulation Laboratory	PC	0	0	4	2
6	21D90204	Advanced Casting & Welding Lab	PC	0	0	4	2
7	21D90205	Technical seminar	PR	0	0	4	2
8		Audit Course – II	AC	2	0	0	0
	21DAC201a	Pedagogy Studies					
	21DAC201b	Stress Management for Yoga					
	21DAC201c	Personality Development through Life Enlightenment Skills					
Total							**18**

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SEMSTER - III

S.No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21D90301a 21D90301b 21D90301c	**Program Elective Course – V** Design & Manufacturing of MEMS and MICRO Systems Quality Engineering Product Data Management	PE	3	0	0	3
2.	21DOE301c 21DOE301g 21DOE301h	Open Elective Business Analytics Internet Of Things Mechatronics	OE	3	0	0	3
3.	21D90302	Dissertation Phase – I	PR	0	0	20	10
4.	21D90303	Co-curricular Activities					2
		Total					**18**

SEMESTER - IV

S.No.	Course codes	Course Name	Category	Hours per week			Credits
				L	T	P	
1.	21D90401	Dissertation Phase – II	PR	0	0	32	16
		Total					**16**

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Course Code	ADVANCED FINITE ELEMENT METHODS	L	T	P	C
21D04101		3	0	0	3
	Semester	I			

Course Objectives: Student will be able

- To provide the mathematical foundations of the finite element formulation for engineering applications (solids, heat, fluids).
- To expose students to some of the recent trends and research areas in finite elements.

Course Outcomes (CO): Student will be able to

- Study on Heat Transfer problem
- Study on Simple non-linear problem
- Understand Projection tensor
- Derive constitutive equations
- Derive equilibrium equation

UNIT - I	Lecture Hrs:09

Formulation Techniques: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions.

UNIT - II	Lecture Hrs:09

One-dimensional finite element methods: Bar elements, temperature effects. Element matrices, assembling of global stiffness matrix, Application of boundary conditions, Elimination and penalty approaches, solution for displacements, reaction, stresses, temperature effects, Quadratic Element, Heat transfer problems: One-dimensional, conduction and convection problems. Examples: - one dimensional fin.

UNIT - III	Lecture Hrs:09

Trusses: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses, temperature effects. Beams and Frames: Element matrices, assembling of global stiffness matrix, solution for displacements, reaction, stresses.

UNIT - IV	Lecture Hrs:09

Two dimensional problems: CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems: Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin. Isoparametric formulation: Concepts, sub parametric, super parametric elements, numerical integration.

UNIT - V	Lecture Hrs:09

Finite elements in Structural Dynamics: Dynamic equations, eigen value problems, and their solution methods, simple problems. Convergence: Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle.

Textbooks:

1.Finite element methods by Chandraputla & Belagondu.
2.Finite element method in Heat transfer and fluid dynamics, . J.N.Reddy, CRC press,1994

Reference Books:

1. Finite Element Method, Zienckiwicz O.C. & R. L. Taylor,McGraw-Hill,1983.
2.Finite Element of Nonlinear continua, . J. N. Oden, McGraw-Hill, New York, 1971
3.Finite element procedures, . K. J. Bathe, Prentice-Hall, 1996.

Online Learning Resources:

1. nptel.ac.in/courses/112/106/112106130/
2. www.digimat.in/nptel/courses/video/112104193/L01.html

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Course Code	ADVANCES IN MANUFACTURING TECHNOLOGY	L	T	P	C
21D04103a		3	0	0	3
	Semester	I			

Course Objectives: Student will be able to

- Understand Machining principles and processes in the manufacturing of precision components and products that use conventional, nonconventional, and surface engineering technologies.
- Study basic understanding of the machining capabilities, limitations, and productivity of advanced manufacturing processes.

Course Outcomes (CO): Student will be able to

- Apply the working principles and processing characteristics of ultra-precision machining, high-speed machining methods, and non-traditional machining to the production of precision components.
- Determine the quality and surface integrity of products treated by surface engineering processes.
- Determine the formability of a given material and geometric combination using fine-blanking processes.
- Prescribe a laser materials processing technique suitable for a given product with material, size, precision, and surface quality requirements.

UNIT - I		Lecture Hrs:09

Surface Processing Operations: Plating and Related Processes, Conversion Coatings, Physical Vapor Deposition, Chemical Vapor Deposition, Organic Coatings, Porcelain Enameling and other Ceramic coatings, Thermal and Mechanical Coating Processes.

UNIT - II		Lecture Hrs:09

Un-conventional Machining Methods: Abrasive jet machining - Elements of the process, mechanics of metal removal process parameters, economic considerations, applications and limitations, recent developments. Ultrasonic machining: Elements of the process, machining parameters, effect of parameters on surface finish and metal removal rate, mechanics of metal removal process parameters, economic considerations, applications and limitations.

UNIT - III		Lecture Hrs:09

Electro-Chemical Processes: Fundamentals of electro chemical machining, metal removal rate in ECM, Tool design, Surface finish and accuracy economics aspects of ECM. Wire EDM Process: General Principle and applications of Wire EDM, Mechanics of metal removal, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy.

UNIT - IV		Lecture Hrs:09

Electron Beam Machining: Generation and control of electron beam for machining, theory of electron beam machining, principle, advantages, limitations, comparison of thermal and nonthermal processes. Plasma Arc Machining: Principle, machining parameters, effect of machining parameters on surface finish and metal removal rate, applications, limitations.

UNIT - V		Lecture Hrs:09

Laser Beam Machining: Principle, effect of machining parameters on surface finish, applications, and limitations. Rapid Prototyping: Working principle, methods-Steriolithography, Laser sintering, Fused deposition method, applications and limitations.

Textbooks:

1. Manufacturing Technology - P. N. Rao, TMH Publishers
2. Fundamentals of Modern Manufacturing, Mikell P. Groover, John Wiley & Sons Publishers

Reference Books:

1. Production Technology - HMT
2. Manufacturing Science - Cambel
3. Welding Technology - R.S, Parmar,
4. Introduction to Nanotechnology - Poole and Owens, Wiley (2003).

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Online Learning Resources:
1.NPTEL 2.SWAYAM

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COURSE STRUCTURE & SYLLABI

Course Code	COMPUTATIONAL METHODS	L	T	P	C
21DBS101	Program Elective Course - I	3	0	0	3
	Semester	I			

Course Objectives:

- Students will demonstrate aptitude in standard numerical techniques for solving various classes of problems.
- Students will learn the theory underlying the derivation of standard numerical techniques and the development of algorithms.
- Modelling of engineering problems drawn from different disciplines of mechanical engineering.

Course Outcomes (CO): Student will be able to

- To enable students to formulate and solve engineering problems that is not amenable to analytical methods.
- To demonstrate the application of numerical methods to data analysis and optimal design.

UNIT - I		Lecture Hrs:09

Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of non-linear equations – computer programs Numerical integration: Newton-Cotes integration formulas – Simpson's rules, Gaussian quadrature. Adaptive integration.

UNIT - II		Lecture Hrs:09

Optimization: One dimensional unconstrained optimization, multidimensional unconstrained optimization –direct methods and gradient search methods, constrained optimization Boundary value problems and characteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems.

UNIT - III		Lecture Hrs:09

Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.

UNIT - IV		Lecture Hrs:09

Parabolic partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria – Finite element for heat flow – computer programs. Hyperbolic partial differential equations: Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions computer programs.

UNIT - V		Lecture Hrs:09

Curve fitting and approximation of functions: Least square approximation fitting of nonlinear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs.

Textbooks:

1. "Numerical Methods for Engineers", Steven C.Chapra, Raymond P.Canale Tata Mc-Graw hill
2. "Applied numerical analysis", Curtis F.Gerald, partick.O.WheatlyAddison-wesley,1989
3. "Numerical methods", Douglas J..Faires,Riched BurdenBrooks/cole publishing company,1998.Second edition.

Reference Books:

1. "Numerical mathematics and computing", Ward cheney &David Kincaid Brooks/Cole publishing company1999,fourth edition.
2. "Mathematical methods for physics and engineering"Riley K.F.M.P.Hobson.&.Bence S.J.Cambridge university press,1999.

Online Learning Resources:

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY ANANTAPUR
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1. nptel.ac.in/noc/courses/noc15/SEM1/noc15-ch04/
2. https://www.nature.com/subjects/computational-methods#:~:text=Computational%20models%20are%20mathematical%20models,means%20of%20a%20computer%20simulation.
3. https://www.sciencedirect.com/topics/computer-science/computational-method

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Course Code	DESIGN FOR MANUFACTURING	L	T	P	C
21D04301b	Program Elective Course - I	3	0	0	3
	Semester	I			

Course Objectives:

- Internalize the attributes along which the success or failure of a manufacturing process, machine, or system will be measured: quality, cost, rate and flexibility.
- Provide exposure to a range of current industrial processes and practices used to manufacture products in high and low volumes. Focus in depth on a few selected processes.
- Understand the impact of manufacturing constraints on product design and process planning.

Course Outcomes (CO): Student will be able to

- Concepts of Design for Manufacturing (DFM); Role of DFM in product specification and standardization.
- Methods of material, shape and process selections.
- Design rules for manufacturing and assembly processes.
- Design for quality and reliability, Approach towards robust design, Design for optimization.
- Case studies on design for manufacturing and assembly.

UNIT - I	Lecture Hrs:09

Introduction: Design philosophy-steps in design process-general design rules for manufacturability-basic principles of designing 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.

UNIT - II	Lecture Hrs:09

Machining processes: 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.

UNIT - III	Lecture Hrs:09

Metal casting: Appraisal of various casting processes, selection of casting process,-general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting.

UNIT - IV	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.

UNIT - V	Lecture Hrs:09

Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations. Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.

Textbooks:

1. Design for manufacture, John cobert, Adisson Wesley. 1995
2. Design for Manufacture by Boothroyd,

Reference Books:

1. ASM Hand book Vol.20

Online Learning Resources:

1. nptel.ac.in/courses/112/101/112101005/
2. nptel.ac.in/courses/107/103/107103012/

Course Code	RAPID PROTOTYPING	L	T	P	C

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21D90101	Program Elective Course - I	3	0	0	3
Semester		I			

Course Objectives:

- At the end of this course the students would have developed a thorough understanding of the principle methods, areas of usage, possibilities and limitations as well as environmental effects of the Rapid Prototyping Technologies.

Course Outcomes (CO): Student will be able to

- It helps the students to get familiarized with the various methods of rapid prototyping technologies and rapid tooling.

UNIT - I	Lecture Hrs:09

Introduction: Need for the compression in product development, History of RP system, Survey of applications, Growth of RP industry and classification of RP system. Stereo Lithography System: Principle, Process parameter, Process details, Data preparation, Data files and machine details, Applications.

UNIT - II	Lecture Hrs:09

Fusion Decomposition Modeling: Principle, process parameter, Path generation, Applications. Solid ground curing: Principle of operation, Machine details, Applications.

UNIT - III	Lecture Hrs:09

Laminated Object Manufacturing: Principle of Operation, LOM materials, Process details, Applications. Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer, Genesis Xs printer HP system 5, Object Quadra system.

UNIT - IV	Lecture Hrs:09

LASER ENGINEERING NET SHAPING (LENS) Rapid Tooling: Indirect Rapid tooling- Silicon rubber tooling- Aluminum filled epoxy tooling Spray metal tooling, Cast kriksite, 3Q keltool, etc, Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft, Tooling vs. hard tooling. Software for RP: STL files, Overview of Solid view, magics, imics, magic communication, etc. Internet based software, Collaboration tools.

UNIT - V	Lecture Hrs:09

Rapid Manufacturing Process Optimization: Factors influencing accuracy, Data preparation error, Part building error, Error in finishing, Influence of build orientation.

Textbooks:

1. " Stereo lithography and other RP & M Technologies", Paul F.Jacobs, SME, NY 1996
2. " Rapid Manufacturing ", Flham D.T & Dinjoy S.S, Verlog London 2001
3. "Rapid automated", Lament wood, Indus Press New York.

Reference Books:

Textbook of Rapid Prototyping Ramesh S

Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc20_me50/preview
2. nptel.ac.in/noc/courses/noc19/SEM1/noc19-me24/

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Course Code	ADVANCED OPTIMIZATION TECHNIQUES	L	T	P	C
21D04201	Program Elective Course – II	3	0	0	3
	Semester	I			

Course Objectives:

The general objectives of the course is

- To introduce the fundamental concepts of Optimization Techniques;
- To make the learners aware of the importance of optimizations in real scenarios;
- To provide the concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.

Course Outcomes (CO): Student will be able to

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

- Formulate optimization problems.
- Understand and apply the concept of optimality criteria for various type of optimization problems.
- Solve various constrained and unconstrained problems in single variable as well as multivariable;
- Apply the methods of optimization in real life situation.

UNIT - I — 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.
Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method.

UNIT - II — Lecture Hrs:09

Integer programming- cutting plane method and branch and bound technique**. Geometric Programming:** Unconstrained & Constrained Minimization

UNIT - III — Lecture Hrs:09

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,
Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, solving differential equations using GP.

UNIT - IV — Lecture Hrs:09

Multi-Objective Optimization : Introduction to goal programming , Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems . Introduction to Analytical hierarchical process, analytical network process.

UNIT - V — Lecture Hrs:09

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, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence.

Textbooks:

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
4. Operation Research by Hamdy A. Taha, Pearson publications

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
4. Fundamentals of Metal cutting and Machine tools , B.L.Juneja, G. S. Sekhom and Nitin Seth ,

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New Age International publishers
5. Tool Engineering, G.R.Nagpal, Khanna Publishers

Online Learning Resources:

1. https://www.youtube.com/watch?v=eo2tOPV3AoE
2. https://www.youtube.com/watch?v=4t3z8y4CAcs
3. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-0002-introduction-to-computational-thinking-and-data-science-fall-2016/lecture-videos/lecture-1-introduction-and-optimization-problems/
4. https://ocw.mit.edu/courses/sloan-school-of-management/15-093j-optimization-methods-fall-2009/lecture-notes/
5. https://web.eng.fiu.edu/arleon/courses/Optimization/Lectures/Classical_Optimization.pdf
6. https://nptel.ac.in/content/storage2/courses/105108127/pdf/Module_1/M1L4_LN.pdf
7. https://www.iare.ac.in/sites/default/files/OT%20Complete%20Notes_1.pdf

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Course Code	MECHANICAL VIBRATIONS	L	T	P	C
21D15203a	Program Elective Course – II	3	0	0	3
Semester		I			

Course Objectives: Student will be able to

- Understand basic and intermediate concepts necessary for the analysis of the dynamics of complex structures under various loading conditions.
- Knows syllabus ME 56300 – Mechanical Vibrations: Explain and correlate the structural properties of complex structures to the overall vibration characteristics in order to design systems having required dynamical properties.
- Apply theoretical and numerical procedures to predict the dynamic response of discrete or continuous structural systems under the most diverse loading conditions.
- Develop reduced order models to treat systemswith a large number of DOF. Understand and implement approximate methods for the numerical solution of distributed parameter systems.
- Understand the main features of the dynamics of nonlinear lumped parameters systems.

Course Outcomes (CO): Student will be able to

- Cover fundamental concepts on the vibration of mechanical systems including, but not limited to, review of systems with one degree for freedom, Lagrange's equations of motion for multiple degree of freedom systems,
- Introduction to matrix methods, transfer functions for harmonic response, impulse response, and step response, convolution integrals for response to arbitrary inputs, principle frequencies and modes, applications to critical speeds, measuring instruments, isolation, torsional systems, introduction to nonlinear problems.

UNIT - I Lecture Hrs:09

Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation; Vibration isolation and transmissibility.
Response to Non Periodic Excitations: unit Impulse, unit step and unit Ramp functions; responseto arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method.

UNIT - II Lecture Hrs:09

Vibration measuring instruments : Vibrometers, velocity meters & accelerometers
Two degree freedom systems: Principal modes – undamped and damped free and forced vibrations ; undamped vibration absorbers ;

UNIT - III Lecture Hrs:09

Multi degree freedom systems: Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems.

UNIT - IV Lecture Hrs:09

Numerical Methods: Rayliegh's, stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods.

UNIT - V Lecture Hrs:09

Continuous systems: Free vibration of strings – longitudinal oscillations of bars-traverse vibrations of beams- Torsional vibrations of shafts.
Critical speeds of shafts: Critical speeds without and with damping, secondary critical speed.

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Textbooks:
1. Elements of Vibration Analysis by Meirovitch. 2. Mechanical Vibrations by G.K. Groover.
Reference Books:
1. Vibrations by W.T. Thomson 2. Mechanical Vibrations – Schaum series. 3. Vibration problems in Engineering by S.P. Timoshenko. 4. Mechanical Viabrations – V.Ram Murthy
Online Learning Resources:
• https://nptel.ac.in/courses/112/103/112103112/ • https://youtu.be/NqiGVeOn9cY • https://youtu.be/KcWCkNdEQfs • https://youtu.be/s287PPKRXBU • https://youtu.be/LaxkM1B3Lm4 https://www.youtube.com/watch?v=bn8Ztp3kTq8

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Course Code	GEOMETRICAL DIMENSIONING AND	L	T	P	C
21D90102	TOLERANCES (PE – II)	3	0	0	3
	Semester	I			

Course Objectives:

- Teach the basics of the geometric dimensioning and tolerances.
- Familiar with the form and orientation tolerances.
- Introduce tolerances of profiles of lines and surfaces with or without datums.
- Expose the students to various surface roughness parameters and their measurements in two dimensions.
- Understand the concepts of dimensional chains and inspection techniques.

Course Outcomes (CO): Student will be able to

- Introduces the essentials of the language of geometric dimensioning and tolerancing (GD&T) based on ASME and ISO standards, as well as the essentials of surface roughness measurements in both 2D and 3D including filtering techniques.
- Introduces the related concepts of Vectorial dimensioning and tolerancing, dimensional chains, measurement uncertainty, etc.
- Perform very well in their profession as metrologists as well as product designers.

UNIT - I	**Basic Concepts**	Lecture Hrs:09

General terms and definitions of geometrical features - General principle of sizes - System of limits and fits - Principles of dimensioning - Introduction to geometric dimensioning and tolerancing (GD&T) - Inspection of dimensional and geometrical deviations - Datums and datum systems. Rule #1 and Rule #2- Boundary principle.

UNIT - II		Lecture Hrs:09

Form and Orientation Tolerances 10 Hours
Form tolerances: types, specifications and interpretations - measurement and evaluation of straightness, flatness and roundness - Orientation tolerances: types, specifications and interpretations, and verification of orientation tolerances. Exercises on each group.

UNIT - III		Lecture Hrs:09

Location, Runout and Profile Tolerances 10 Hours
Tolerances of location: types, specifications and interpretations - verification techniques - Tolerances of profiles of lines and surfaces with or without datums - Tolerances of runout -Tolerancing of angles and cones. Exercises on each group.

UNIT - IV		Lecture Hrs:09

Surface Roughness 8 Hours
Various parameters and their measurements in two dimensions - filtering and filtering techniques - areal parameters.

UNIT - V		Lecture Hrs:09

Related Topics 9 Hours
Vectorial dimensioning and tolerancing - Statistical tolerancing of mechanical assemblies - Dimensional chains - Measurement uncertainty - Computer-aided tolerancing and verification. Inspection techniques- conventional and CMM.

Textbooks:

1. Drake, P. J., Dimensioning and Tolerance Handbook, McGraw-Hill, Inc., New York.
2. Meadows, J. D., Geometric Dimensioning and Tolerancing Applications and Techniques for use in Design, Manufacturing and Inspection, Marcel Dekker, Inc.,New York.
3. Gill, P. S., Geometric Dimensioning and Tolerancing, S. K. Kataria & Sons, New Delhi.

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
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Reference Books:

1. Gupta, I. C., A Textbook of Engineering Metrology, Dhanpat Rai Publications, New Delhi.
2. Galyer, J. F. W. and C. R. Shotbolt, Metrology for Engineers, Cassell Publishers, London.
3. Henzold, G., Handbook of Geometrical Tolerancing Design, Manufacturing and Inspection, John Wiley & Sons, Chichester.
4. Muralikrishnan, B. and J. Raja, Computational Surface and Roundness Metrology, Springer, USA.
5. Relevant Indian and International Standards.
6. Whitehouse, D. J., Surfaces and their Measurement, Hermes Penton Science, London

Online Learning Resources:

1. http://www.pages.drexel.edu/~rcc34/Files/Teaching/MEM201%20L6-Tolerance_RC.pdf
2. https://www.youtube.com/watch?v=aS9OgYadjpY
3. https://www.youtube.com/watch?v=X_VepJhq_vk

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	DESIGN SIMULATION LABORATORY	L	T	P	C
21D90103		0	0	4	2
	Semester	I			

Course Objectives:

- Understand the Various Modelling processess

Course Outcomes (CO):

- Deign the 1-D,2-D & 3-D element

List of Experiments:

I. Modeling

1. Surface modeling
2. Solid modeling
3. Drafting
4. Assembling

II. Structural Analysis using any FEA Package for different structures that can be discretised with 1-D,2-D & 3-D elements

1. Static Analysis
2. Modal Analysis
3. Harmonic Analysis
4. Spectrum Analysis
5. Buckling Analysis
6. Analysis of Composites
7. Fracture mechanics

References:

User manuals of ANSYS package Version 10.0 PRO/E, I-DEAS Package /UNIGRAPHICS, CATIA

Online learning resources/Virtual labs:

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	ADVANCED MANUFACTURING PROCESSES & METAL CUTTING Laboratory	L	T	P	C
21D90104		0	0	4	2
	Semester	I			

Course Objectives:

- Understand the Machining processes

Course Outcomes (CO):

- Design the MRR on 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
Note: Conduct any Ten exercises from the list given above

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COURSE STRUCTURE & SYLLABI

Course Code	**RESEARCH METHODOLOGY AND IPR**	**L**	**T**	**P**	**C**
21DRM101		**2**	**0**	**0**	**2**
	Semester	**I**			

Course Objectives:

- Identify an appropriate research problem in their interesting domain.
- Understand ethical issues understand the Preparation of a research project thesis report.
- Understand the Preparation of a research project thesis report
- Understand the law of patent and copyrights.
- Understand the Adequate knowledge on IPR

Course Outcomes (CO): Student will be able to

- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

UNIT - I	Lecture Hrs:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, scope, and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT - II	Lecture Hrs:

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT - III	Lecture Hrs:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT - IV	Lecture Hrs:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT - V	

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Textbooks:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

Reference Books:

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COURSE STRUCTURE & SYLLABI

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	SIMULATION OF MANUFACTURING SYSTEMS	L	T	P	C
21D90201		3	0	0	3
	Semester	II			

Course Objectives: Student will be able to

- To impart knowledge about the energy interaction of different components of a system.
- To model systems residing in different energy domains and to control directly the theoretical and real systems.
- Provide students with the ability to apply modelling technique for analysis and synthesis of thermal, mechanical, biological systems etc.

Course Outcomes (CO): Student will be able to

- Introducing simulation tool
- Explaining the concept and types of models
- Understanding discrete and continuous simulation
- Introducing various simulation languages and software
- Understanding the role of probability distributions in simulation
- Explaining the verification and validation of simulation models.

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 and Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1 & 2 errors – Framing – Strang 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.

UNIT - III — Lecture Hrs:09

Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling. Generation of random variants – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – Weibull – normal Bernoullie – Binomial – uniform – Poisson.

UNIT - IV — Lecture Hrs:09

Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN-SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.QUEST, WITNESS, PROMODEL and AUTOMOD.

UNIT - V — Lecture Hrs:09

Output data analysis – Types of Simulation with respect to output data analysis – warm up period-Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – Newboy paper problem.

Textbooks:

1. Simulation Modelling and Analysis, Law, A.M.& Kelton, McGraw Hill,
2nd Edition, New York, 1991. 2. Discrete Event System Simulation, Banks J. & Carson J.S., PH , Englewood Cliffs, NJ, 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 SIMNET , Taha H.A. , PH, Englewood Cliffs, NJ, 1987
6. Performance modeling and analysis of manufacturing systems, Viswanat Narahari, PHI

Reference Books:

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COURSE STRUCTURE & SYLLABI

1. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, England 2005.
2. Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press
3. Davies, J.H. „The Physics of Low Dimensional Semiconductors: An Introduction", Cambridge University Press, 1998.

Online Learning Resources:

1. https://nptel.ac.in/courses/112/107/112107220/
2. https://youtu.be/Ej26SZrcPAg
3. https://nptel.ac.in/courses/112/107/112107214/
4. https://nptel.ac.in/courses/110/104/110104096/

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	AUTOMATION IN MANUFACTURING	L	T	P	C
21D87101		3	0	0	3
	Semester	II			

Course Objectives:

- To study the types and strategies and various components in Automated Systems.
- To understand the automated flow lines, line balancing, material storage and retrieval and inspection
- To learn the adaptive control systems.

Course Outcomes (CO): Student will be able to

- Learn to Solve the line balancing problems in the various flow line systems with and without use buffer storage
- Understand the different automated material handling, storage and retrieval systems and automated inspection systems.
- Use of Adaptive Control principles and implement the same online inspection and control

UNIT - I Lecture Hrs:09

Introduction to Automation: Automation in Production Systems-Automated Manufacturing Systems, Computerized Manufacturing Support Systems, Reasons for Automation, Automation Principles and Strategies. Basic Elements of an Automated Systems, Advanced Automation Functions, Levels of automation.

UNIT - II Lecture Hrs:09

Introduction to Material Handling, Overview of Material Handling Equipment, Material Handling System Design considerations, Principles of Material Handling. Material Transport Systems, Automated Guided Vehicle Systems, Monorails and other Rail Guided Vehicles, Conveyor Systems, Analysis of Material Transport Systems.

UNIT - III Lecture Hrs:09

Storage Systems, Storage System Performance, Storage Location Strategies, Conventional Storage Methods and Equipment, Automated Storage Systems, Engineering Analysis of Storage Systems. Automatic data capture-overview of Automatic identification methods, bar code technology, other ADC technologies.

UNIT - IV Lecture Hrs:09

Line balancing problem, largest candidate rule, Kilbridge and Wester method, and Ranked Positional Weights Method, Mixed Model Assembly Lines, assembly line design considerations. Transfer lines, Fundamentals of Automated Production Lines, Storage Buffers, and Applications of Automated Production Lines. Analysis of Transfer Lines with and without Storage buffers.

UNIT - V Lecture Hrs:09

Manual Assembly Lines - Fundamentals of Manual Assembly Lines, Alternative Assembly Systems, Design for Assembly, Analysis of Single Model Assembly Lines, Automated Assembly Systems, Fundamentals of Automated Assembly Systems, Design for Automated Assembly, and Quantitative Analysis of Assembly Systems - Parts Delivery System at Work Stations, MultiStation Assembly Machines, Single Station Assembly Machines , Partial Automation.

Textbooks:

1. Automation, Production systems and computer integrated manufacturing, Mikel P. Groover, Pearson Eduction.

Reference Books:

1. CAD CAM : Principles, Practice and Manufacturing Management, Chris Mc Mohan, Jimmie Browne , Pearson edu. (LPE)
2. Automation, Buckinghsm W, Haper & Row Publishers, New York, 1961
3. Automation for Productivity, Luke H.D, John Wiley & Sons, New York, 1972.

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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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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	INDUSTRIAL ROBOTICS	L	T	P	C
21D87203b	Program Elective Course – III	3	0	0	3
	Semester	II			

Course Objectives: Student will be able to

- 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):

- 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.

UNIT - I — Lecture Hrs:09

Robot – Definition – Robot anatomy – Co-ordinate systems, work envelope, types and classification – Specifications – Pitch, yaw, roll, joint notations, speed of motion and pay load – Robot parts and their functions – Need for robots – Different applications.

UNIT - II — Lecture Hrs:09

Pneumatic drives – Hydraulic drives – Mechanical drives – Electrical drives – D.C. servo motors, stepper motor and A.C. servo motors – Salient features, applications and comparison of all these drives-End effectors – Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers – Two fingered and three fingered grippers – Internal grippers and external grippers – Selection and design considerations.

UNIT - III — Lecture Hrs:09

Requirements of a sensor, principles and applications of the following types of sensors – Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors) – Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters) – Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors) – Touch sensors (Binary sensors, Analog sensors) – Wrist Sensors – Compliance Sensors – Slip Sensors.

UNIT - IV — Lecture Hrs:09

Camera, frame grabber, sensing and digitizing image data – Signal conversion – Image Storage – Lighting techniques – Image processing and analysis – Data reduction – Segmentation – Feature extraction – Object recognition – Other algorithms – Applications – Inspection, identification, visual serving and navigation..

UNIT - V — Lecture Hrs:09

Forward kinematics – Inverse kinematics – Differences: Forward kinematics and Reverse kinematics of manipulators with two and three degrees of freedom (In 2 dimensional), four degrees of freedom (In 3 dimensional) – Deviations and problems-GV – AGV – Implementation of robots in industries – Various steps - Safety considerations for robot operations.

Textbooks:

1.Robotics& Control – R.K. Mittal & I.J. Nagrath – TMH Publications
2.Robotics for engineers - Yoram Korean- McGrew Hill Co.
3.Industrial Robotics Technology programming and Applications - M.P.Groover, M.Weiss, R.N.Nagel, N.G.Odrey.

Reference Books:

1.Robotics Control Sensing, Vision and Intelligence - K.S.Fu, R.C.Gonzalex, C.S.G.Lee- McGrew hill Book co.
2.Kinematics and Synthesis of linkages - Hartenberg and Denavit - McGrew Hill Book Co
3. Kinematics and Linkage Design - A.S. Hall - Prentice Hall
4. Kinematics and Dynamics of Machinary - J.Hirchhorn - McGrew HillBook Company

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Online Learning Resources:
1. nptel.ac.in/courses/112/105/112105249/ 2. nptel.ac.in/content/storage2/courses/112101098/download/lecture-3.pdf 3. nptel.ac.in/courses/112/101/112101099/

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COURSE STRUCTURE & SYLLABI

Course Code	COMPUTER GRAPHICS	L	T	P	C
21D04203b	Program Elective Course – III	3	0	0	3
	Semester	II			

Course Objectives:

- The students can understand the Basics of computer Graphics like drawing line, arc etc.,
- The students can understand Drawing of spline curves, Creation of surfaces, Algorithms for 3D viewing, Available drawing standards.

Course Outcomes (CO): Student will be able to

Understand the following

- Basics of computer Graphics like drawing line, arc etc.
- Drawing of spline curves
- Creation of surfaces
- Algorithms for 3D viewing

UNIT - I		Lecture Hrs:09

Introduction to computer graphics: Color CRT raster scan monitors, plasma display & liquid crystal display monitors, computer input devices, hard copy devices. Raster scan graphics: Line drawing algorithms – DDA & Bresenham algorithms, circle generation, general function rasterization, displaying lines, characters and polygons.

UNIT - II		Lecture Hrs:09

Filling algorithms: polygon filling, edge fill algorithm, seed fill algorithm, fundamentals of antialiasing and half toning.

UNIT - III		Lecture Hrs:09

Line CLIPPING: Simple visibility algorithm, Cohen-Sutherland subdivision line clipping algorithm, midpoint sub division algorithm. Polygon clipping: polygon clipping, re-entrant polygon clipping – Sutherland – Hodgeman algorithm, character clipping, 3D- clipping.

UNIT - IV		Lecture Hrs:09

Transformations: Cartesian and homogeneous coordinate systems two dimensional and three dimensional transformations – scaling, rotation, Shearing, Zooming, viewing transformation, reflection, rotation about an axis, concatenation.

UNIT - V		Lecture Hrs:09

Rendering: Hidden line removal algorithms, surface removal algorithms, painters, Warnock, Zbuffer algorithm. Shading algorithms: Constant intensity algorithm, Phong's shading algorithm, gourand shading algorithm, Comparison of shading algorithms.

Textbooks:

1. Procedural elements for computer graphics-D.F.Rogers, Tata McGraw-Hill.
2. Computer Graphics-Donald Hearn & M.P. Bakers.
3. Computer graphics-Harrington.

Reference Books:

1. Procedural elements for computer graphics-D.F.Rogers, Tata McGraw-Hill.
2. Computer Graphics-Donald Hearn & M.P. Bakers.
3. Computer graphics-Harrington.

Online Learning Resources:

1. https://en.wikipedia.org/wiki/Computer_graphics_(computer_science)#:~:text=Computer%20graphics%20is%20a%20sub,dimensional%20graphics%20and%20image%20processing.
2. nptel.ac.in/courses/106/103/106103224/

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	MATERIAL SCIENCE & TECHNOLOGY	L	T	P	C
21D87203a	Program Elective Course – III	3	0	0	3
	Semester	II			

Course Objectives: The students can understand

- Understand the concept of materials i.e., conventional materials such as metallic and non-metallic materials with their structures and applications.
- Explain the differences in properties of different materials, including metals, alloys, ceramics, polymers and composites.
- Relate the properties of materials to microstructure (quantitative skills).
- Describe the basics of processing techniques for altering the microstructure and properties of different materials.

Course Outcomes (CO): Student will be able to

Define the concept of materials i.e., conventional materials with their structure, such as electronic configuration, structure of atom, etc.

- Aware of different conventional materials such as metallic and non-metallic materials, structures and their applications.
- Demonstrate the need for newer materials by comparing the limitations of conventional materials.
- Compare the types of newer materials along with their properties and applications.
- Compile about the properties, structure of ceramic materials and their need for newer applications and processing techniques.

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. 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 of brittle fracture 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. Simple problems.

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, effect of creep on fatigue. Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis. Selection for Surface durability, Corrosion and Wear resistance, Relationship between Materials Selection and Processing.

UNIT - IV Lecture Hrs:09

Modern Metallic Materials: Dual Phase Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Intermetallics, Ni and Ti Aluminides. Smart Materials, Shape Memory alloys, Metallic Glass, Quasi Crystal and Nano Crystalline Materials. Metal-Matrix composites.

UNIT - V Lecture Hrs:09

Non-metallic Materials: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, Structure, Properties and Applications of engineering Polymers. Advanced structure of ceramics –WC, TiC, Al2O3, SiC, CBN and diamond- properties and applications, Composite Materials.

Textbooks:

1. Mechanical Behaviour of Materials, Thomas H. Courtney, 2nd Edition, McGraw Hill,2000.
2. Mechanical Metallurgy, George E. Dieter, McGraw Hill,1998.

Reference Books:

1. Selection and use of Engineering Materials, Charles J.A, Butterworth Heiremann.

Online Learning Resources:

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1. https://nptel.ac.in/courses/112/108/112108150/
2. https://ocw.mit.edu/courses/materials-science-and-engineering/3-012-fundamentals-of-materials-science-fall-2005/lecture-notes/
3. https://www.vssut.ac.in/lecture-notes.php?url=metallurgical-materials-engineering
4. https://www.researchgate.net/publication/305356293_Advanced_metallic_materials_and_processes
5. https://www.youtube.com/watch?v=yXHlIowQntk
6. https://nptel.ac.in/courses/112/104/112104251/
7. https://www.youtube.com/watch?v=b5IPJeCDEPw
8. https://nptel.ac.in/courses/112/108/112108092

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	MECHANICS & MANUFACTURING METHODS OF COMPOSITES (PE-IV)	L	T	P	C
21D90202a		3	0	0	3
Semester		II			

Course Objectives: Student will be able to

- Develop an understanding of the linear elastic analysis of composite materials.
- Understanding will include concepts such as anisotropic material behavior and the analysis of laminated plates.
- Design project involving application of fiber reinforced laminates.

Course Outcomes (CO): Student will be able to

- Identify the properties of fiber and matrix materials used in commercial composites, as well as some common manufacturing techniques.
- Predict the elastic properties of both long and short fiber composites based on the constituent properties.
- Rotate stress, strain and stiffness tensors using ideas from matrix algebra.

UNIT - I	Lecture Hrs:09

Introduction to Composite Materials: Introduction ,Classification: Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon–Carbon Composites, Fiber-Reinforced Composites and nature-made composites, and applications . Reinforcements: Fibres- Glass, Silica, Kevlar, carbon, boron, silicon carbide, and born carbide fibres. Particulate composites, Polymer composites, Thermoplastics, Thermosetts, Metal matrix and ceramic composites. Processing methods: Autoclave, contact moulding, compression moulding, filament winding, man layup, pultrusion, vaccum assisted RTM .

UNIT - II	Lecture Hrs:09

Micromechanical Analysis of a Lamina: Introduction ,Definitions: Stress, Strain ,Elastic Moduli,Strain Energy. Hooke's Law for Different Types of Materials, Hooke's Law for a TwoDimensional Unidirectional Lamina, Plane Stress Assumption, Reduction of Hooke's Law in Three Dimensions to Two Dimensions, Relationship of Compliance and Stiffness Matrix to Engineering Elastic Constants of a Lamina.

UNIT - III	Lecture Hrs:09

Hooke's Law for a Two-Dimensional Angle Lamina, Engineering Constants of an Angle Lamina, Invariant Form of Stiffness and Compliance Matrices for an Angle Lamina Strength Failure Theories of an Angle Lamina : Maximum Stress Failure Theory Strength Ratio,Failure Envelopes,Maximum Strain Failure Theory ,Tsai–Hill Failure Theory, Tsai–Wu Failure Theory, Comparison of Experimental Results with Failure Theories. Hygrothermal Stresses and Strains in a Lamina: Hygrothermal Stress–Strain Relationships for a Unidirectional Lamina, Hygrothermal Stress–Strain Relationships for an Angle Lamina.

UNIT - IV	Lecture Hrs:09

Micromechanical Analysis of a Lamina :Introduction, Volume and Mass Fractions, Density, and Void Content, Evaluation of the Four Elastic Moduli, Strength of Materials Approach, Semi Empirical Models ,Elasticity Approach, Elastic Moduli of Lamina with Transversely Isotropic Fibers, Ultimate Strengths of a Unidirectional Lamina, Coefficients of Thermal Expansion, Coefficients of Moisture Expansion.

UNIT - V	Lecture Hrs:09

Macro mechanical Analysis of Laminates: Introduction , Laminate Code , Stress–Strain Relations for a Laminate, In-Plane and Flexural Modulus of a Laminate , Hygrothermal Effects in a Laminate, Warpage of Laminates. Failure, Analysis, and Design of Laminates : Introduction , Special Cases of Laminates, Failure Criterion for a Laminate, Design of a Laminated Composite, Other Mechanical Design Issues.

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Textbooks:
1. Engineering Mechanics of Composite Materials by Isaac and M Daniel, Oxford University Press, 1994. 2. B. D. Agarwal and L. J. Broutman, Analysis and performance of fibre Composites, Wiley-Interscience, New York, 1980. 3. Mechanics of Composite Materials, Second Edition (Mechanical Engineering), By Autar K. Kaw, Publisher: CRC
Reference Books:
1. R. M. Jones, Mechanics of Composite Materials, Mc Graw Hill Company, New York, 1975. 2. L. R. Calcote, Analysis of Laminated Composite Structures, Van Nostrand Rainfold, New York, 1969.
Online Learning Resources:
1. nptel.ac.in/courses/112/104/112104221/ 2. nptel.ac.in/content/syllabus_pdf/112104221.pdf 3. nptel.ac.in/noc/courses/noc19/SEM2/noc19-me67/

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COURSE STRUCTURE & SYLLABI

Course Code	ADVANCED KINEMATICS OF MECHANISMS	L	T	P	C
21D90202b	Program Elective Course – IV	3	0	0	3
Semester		II			

Course Objectives: Student will be able to

- Develop student understanding of the theoretical background for basic and advanced kinematics and synthesis of mechanisms to achieve desired motion.
- Introduce students to basic and advanced computer-based tools for analysis and synthesis of mechanisms.
- Provide an opportunity for students to use theory and application tools through a major mechanism design project.
- Improve student ability to communicate understanding of the subject through professional technical reports and oral presentations.

Course Outcomes (CO): Student will be able to

- Study of advanced topics in kinematics with a focus of mechanism synthesis techniques.
- Understand the course will primarily focus on planar mechanism, but will also treat spherical and spatial mechanisms.

UNIT - I — Lecture Hrs:09

Introduction: Elements of Mechanisms; Mobility Criterion for Planar mechanisms and manipulators; Mobility Criterion for spatial mechanisms and manipulators. Spherical mechanisms-spherical trigonometry. Kinematics of plane motion- I: The Inflection circle ; Euler – Savary Equation; Analytical and graphical determination of di ; Bobillier's Construction ;Collineastion axis ; Hartmann's Construction ;Inflection circle for the relative motion of two moving planes; Application of the Inflection circle to kinematic analysis.

UNIT - II — Lecture Hrs:09

Kinematics of plane motion - II: Polode curvature; Hall's Equation; Polode curvature in the four bar mechanism; coupler motion; relative motion of the output and input links; etermination of the output angular acceleration and its Rate of change; Freudenstein's collineation –axis theorem; Carter –Hall circle; The circling – point curve for the Coupler of of a four bar mechanism.

UNIT - III — Lecture Hrs:09

Introduction to Synthesis-Graphical Methods: The Four bar linkage ;Guiding a body through Two distinct positions; Guiding a body through Three distinct positions; The Rotocenter triangle ; Guiding a body through Four distinct positions; Burmester's curve. Function generation- General discussion; Function generation: Relative –rotocenter method, Overlay's method, Function generation- Velocity – pole method; Path generation: Hrones's and Nelson's motion Atlas, Roberts's theorem.

UNIT - IV — Lecture Hrs:09

Introduction to Synthesis - Analytical Methods: Function Generation: Freudenstien's equation, Precision point approximation, Precision – derivative approximation; Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition; Method of components; Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link; Method of components.

UNIT - V — Lecture Hrs:09

Manipulator kinematics: D-H notation, D-H convention of assignment of co-ordinate frames and link parameters table; D-H transformation matrix ; Direct and Inverse kinematic analysis of Serial manipulators: Articulated ,spherical & industrial robot manipulators- PUMA, SCARA,STANFORD ARM, MICROBOT. Differential kinematics Formulation of Jacobian for planar serial manipulators and spherical manipulator; Singularity analysis.

Textbooks:

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1. Jeremy Hirschhorn, Kinematics and Dynamics of plane mechanisms, McGraw-Hill,1962.
2. L.Sciavicco and B.Siciliano, Modelling and control of Robot manipulators, Second edition, Springer -Verlag,London,2000.
3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. E.W.P.Publishers.

Reference Books:

1. Allen S.Hall Jr., Kinematics and Linkage Design, PHI,1964.
2. J.E Shigley and J.J . Uicker Jr., Theory of Machines and Mechanisms , McGraw-Hill, 1995.
3. Mohsen Shahinpoor, A Robot Engineering Text book,Harper & Row Publishers, New York,1987.
4. Joseph Duffy, Analysis of mechanisms and Robot manipulators, Edward Arnold,1980

Online Learning Resources:

1. nptel.ac.in/courses/112/105/112105268/
2. nptel.ac.in/courses/112/104/112104121/
3. https://www.iitk.ac.in/me/ME352

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	ADVANCED METAL FORMING PROCESSES	L	T	P	C
21D90202c	Program Elective Course – IV	3	0	0	3
Semester		II			

Course Objectives: Student will be able

- To study and observe through demonstration the metal forming processes (Rolling, Forging and Sheet metal forming).

Course Outcomes (CO): Student will be able to

- Acquire a deeper knowledge about metal forming under different conditions and in various processes.
- Understand the Metal forming fundamentals and applications.
- Understand the Metal forming mechanics.
- Understand the Workability of testing techniques.

UNIT - I	Lecture Hrs:09

Fundamentals of Metal Forming: Classification of forming processes, mechanisms of metal forming: slab method, Upper and lower bound analysis, Deformation energy method and finite element method. Rolling of metals: Rolling processes, forces and geometrical relationship in rolling, simplified analysis, rolling load, rolling variables, theories of cold and hot rolling, problems and defects in rolling, torque and power calculations, Problems.

UNIT - II	Lecture Hrs:09

Forging: Classification of forging processes, forging of plate, forging of circular discs, open die and closed-die forging, forging defects, and powder metallurgy forging. problems on flow stress ,true strain and forging load. Extrusion: Classification, Hot Extrusion, Analysis of Extrusion process, defects in extrusion, extrusion of tubes, production of seamless pipes. Problems on extrusion load.

UNIT - III	Lecture Hrs:09

Press tool design: Design of various press tools and dies like piercing dies, blanking dies, compound dies and progressive blanking dies, design of bending, forming. Sheet Metal forming: Forming methods, Bending, stretch forming, spinning and Advanced techniques of Sheet Metal Forming, Forming limit criteria, and defect in formed parts.

UNIT - IV	Lecture Hrs:09

Drawing: Drawing of tubes, rods, and wires: Wire drawing dies, tube drawing process, analysis of wire, deep drawing and tube drawing. Problems on draw force. Design of drawing dies.

UNIT - V	Lecture Hrs:09

Advanced Metal forming processes: HERF, Electromagnetic forming, residual stresses, inprocess heat treatment and computer applications in metal forming. Problems on Blanking force, Blank diagram in Cup Diagram, Maximum considering shear.

Textbooks:

1. Mechanical Metallurgy, G.E. Dieter , Tata McGraw Hill, 1998. III Edition
2. Principles of Metal Working , Sunder Kumar.

Reference Books:

1. Principles of Metal Working processes , G.W. Rowe 2. ASM Metal Forming Hand book.

Online Learning Resources:

1. https://www.coursera.org/lecture/aerospace-materials/1-3a-metal-forming-processes-part1-xi5hQ
2. slideplayer.com/slide/6642769/
3. nptel.ac.in/courses/112/107/112107250/

Course Code	MANUFACTURING SIMULATION LABORATORY	L	T	P	C

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

21D90203		**0**	**0**	**4**	**2**
	Semester	**II**			

Course Objectives: Student will be able to

- Impart the fundamental knowledge on using various analytical tools like ANSYS, FLUENT, etc., for Engineering Simulation.
- Know various fields of engineering where these tools can be effectively used to improve the output of a product.
- Impart knowledge on how these tools are ued in Industries by solving some real time problems using these tools.

Course Outcomes (CO): Student will be able to

- Appreciate the utility of the tools like ANSYS or FLUENT in solving real time problems and day to day problems.
- Use of these tools for any engineering and real time applications.
- Acquire knowledge on utilizing these tools for a better project in their curriculum as well as they will be prepared to handle industry problems with confidence when it matters to use these tools in their employment.

List of Experiments:

1. Study of elements , entities , activities and basic models of a simulation package modeling and simulation
2. Throughput analysis of a individual production facility using simulation.
3. Modeling of a typical manufacturing facility and study its performances.
4. Breakdown analysis of a production facility with one machine.
5. Breakdown analysis of a production system having multiple machines.
6. Modeling and Simulation of layouts.
7. Study of transport system in a shop floor.
8. Buffer size design.
9. Identification of bottleneck machine on a given shop floor.
10. Study of conjunction, collision and dead locks through simulation.

Lab Facilities

Adequate number of Computer Systems in Networked Environment Packages:

1. QUEST
2. PROMODEL
3. FLEXSIM
4. AUTOMOD
5. WITNESS

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	ADVANCED CASTING & WELDING LAB	L	T	P	C
21D90204		0	0	4	2
	Semester	II			

Course Objectives: Students can able to

- Understand Tensile Strength & Hardness Evaluation of TIG Welded Specimens
- Understand Tensile Strength & Hardness Evaluation of MIG Welded Specimens
- study inclusion analysis of cast specimen
- Size analysis of Grainsfor cast specimens.
- Studyof Non destructive Testing of welded joint and Blow moulding.

Course Outcomes (CO):

- PerformTensile Strength & Hardness Evaluation of TIG Welded Specimens
- Perform Tensile Strength & Hardness Evaluation of MIG Welded Specimens
- Analyze inclusion analysis of cast specimen
- Develop Size analysis of Grains for cast specimens.
- To conduct of Non destructive Testing of welded joint and Blow moulding**.**

List of Experiments:

1. Tensile Strength Evaluation of TIG Welded Specimens under variable conditions.
2. Hardness Evaluation of TIG Welded Specimens under variable conditions.
3. Tensile Strength Evaluation of MIG Welded Specimens under variable conditions.
4. Hardness Evaluation of MIG Welded Specimens under variable conditions.
5. Inclusion Analysis of Cast Specimens
6. Size Analysis of Grains for Cast Specimens under different input variables
7. Design of Runner & Riser
8. Non-Destructive Testing of Welded Joint
9. Study of Blow Moulding
10. Study of Injection Moulding

Note: Each experiment involves preparation of Joint/ Casting, specimen preparation, testing, evaluation and reporting may be chosen from the above list.

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	DESIGN AND MANUFACTURING OF MEMS AND MICRO SYSTEMS (PE-V)	L	T	P	C
21D90301a		3	0	0	3
	Semester	III			

Course Objectives: Student will be able

- To introduce students to the basics MEMS and Microsystems.
- To help the students to design MEMS based structures.
- To make students understand the various methods of fabrication.

Course Outcomes (CO): Student will be able to

- Complete this course will be able to understand the basics of MEMS and analyze a MEMS based structure.

UNIT - I — Lecture Hrs:09

Overview and working principles of MEMS and Microsystems: MEMS and Microsystems, Evolution of Micro fabrication, Microsystems and Microelectronics, Microsystems and miniaturization, Applications of MEMs in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics. Atomic structure of Matter, Ions and Ionization, Molecular Theory of Matter and Intermolecular Forces, Doping of Semiconductors, The Diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics.

UNIT - II — Lecture Hrs:09

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. Overview of Basics of Fluid Mechanics in Macro and Mesoscales, 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.

UNIT - III — Lecture Hrs:09

Overview of Heat conduction in Solids, Heat Conduction in Multilayered Thin films and in solids in sub micrometer scale, Design Considerations, Process Design.

UNIT - IV — Lecture Hrs:09

Mechanical Design, Mechanical design using FEM, Design of a Silicon Die for a Micro pressure sensor.

UNIT - V — Lecture Hrs:09

Materials for MEMS and Microsystems and their fabrication: 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 and Microsystems. Design and Manufacturing, Tia-Ran Hsu, TMH 2002
2. Foundation of MEMS, Chang Liu,Pearson, 2012

Reference Books:

1. An Introduction to Microelectromechanical Systems Engineering. Maluf, M., Artech House, Boston 2000
2. “Micro robots and Micromechnaical Systems”, Trimmer , W.S.N., Sensors & Actuators, Vol 19, 1989
3. Applied Partial Differential Equations, Trim., D.W., PWS-Kent Publishing, Boston, 1990

Online Learning Resources:

1. nptel.ac.in/courses/117/105/117105082/
2. http://www.nptelvideos.in/2012/12/mems-microsystems.html
3. https://iitbmechdamp.wordpress.com/department-electives/me645/

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	QUALITY ENGINEERING	L	T	P	C
21D90301b	Program Elective Course – V	3	0	0	3
	Semester	III			

Course Objectives: Student will be able to

- Impart knowledge about the significance of quality and the various tools/ concepts of building quality into products.
- Learn the techniques used for quality control and quality improvement..

Course Outcomes (CO): Student will be able to

- Apply the tools and techniques of quality to resolve industrial engineering issues.
- Estimate the obvious and hidden quality costs for a given production system.
- Apply a system based approach for quality management.

UNIT - I — Lecture Hrs:09

Quality value and Engineering: An overall quality system, quality engineering in production design, quality engineering in design 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 — Lecture Hrs:09

Tolerance Design and Tolerancing: Functional limits, tolerance design for N-type, L-type and Stype characteristics, tolerance allocation for multiple components. Parameter and tolerance design: Introduction to parameter design, signal to noise ratios, parameter design strategy, Introduction to tolerance design, tolerance design using the Taguchi loss function, identification of tolerance design factors.

UNIT - III — Lecture Hrs:09

Design of Experiments: Introduction, Task aids and Responsibilities for DOE process steps, DOE process steps description. Analysis of variance (ANOVA): One-way ANOVA, two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors.

UNIT - IV — Lecture Hrs:09

Orthogonal Arrays: Typical test strategies, better test strategies, efficient test strategies, conducting and analyzing an experiment. Interpolation of experimental results: Interpretation methods, percent contribution, estimating the mean.

UNIT - V — Lecture Hrs:09

ISO-9000 Quality system, BDRE, Quality improvement Techniques, 6-sigma, bench marking, quality circles-brain storming-fishbone diagram-problem analysis.

Textbooks:

1. Taguchi techniques for quality engineering/Philip J.Ross / McGraw Hill Intl. 2nd Edition, 1995.
2. Total Quality Management by Dale H. Besterfield, Glen Besterfield.

Reference Books:

1. Quality Engineering in Production systems/G.Taguchi, A.Elasayed et al/Mc.Graw Hill Intl. Edition, 1989.
2. Taguchi methods explained: Practical steps to Robust Design/Papan P.Bagchi/Prentice Hall Ind. Pvt. Ltd. New Delhi.

Online Learning Resources:

1. https://nptel.ac.in/courses/112/106/112106253/
2. https://nptel.ac.in/courses/112/107/112107259/
3. https://quality-one.com/quality-engineering/
4. https://en.wikipedia.org/wiki/Quality_engineering

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5. https://youtu.be/5_hng9rgVHE
6. https://www.youtube.com/watch?v=oIG_NDb2g3U
7. https://nptel.ac.in/courses/110/104/110104080/
8. https://nptel.ac.in/courses/110/105/110105088/

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COURSE STRUCTURE & SYLLABI

Course Code	PRODUCT DATA MANAGEMENT	L	T	P	C
21D90301c	Program Elective Course – V	3	0	0	3
	Semester	III			

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.

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

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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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AUDIT COURSE-I

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
21DAC101a		2	0	0	0
	Semester	I			

Course Objectives: This course will enable students:

- Understand the essentials of writing skills and their level of readability
- Learn about what to write in each section
- Ensure qualitative presentation with linguistic accuracy

Course Outcomes (CO): Student will be able to

- Understand the significance of writing skills and the level of readability
- Analyze and write title, abstract, different sections in research paper
- Develop the skills needed while writing a research paper

UNIT - I		Lecture Hrs:10
1Overview of a Research Paper- Planning and Preparation- Word Order- Useful Phrases - Breaking up Long Sentences-Structuring Paragraphs and Sentences-Being Concise and Removing Redundancy -Avoiding Ambiguity		
UNIT - II		Lecture Hrs:10
Essential Components of a Research Paper- Abstracts- Building Hypothesis-Research Problem - Highlight Findings- Hedging and Criticizing, Paraphrasing and Plagiarism, Cauterization		
UNIT - III		Lecture Hrs:10
Introducing Review of the Literature – Methodology - Analysis of the Data-Findings - Discussion-Conclusions-Recommendations.		
UNIT - IV		Lecture Hrs:9
Key skills needed for writing a Title, Abstract, and Introduction		
UNIT - V		Lecture Hrs:9
Appropriate language to formulate Methodology, incorporate Results, put forth Arguments and draw Conclusions		

Suggested Reading

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) Model Curriculum of Engineering & Technology PG Courses [Volume-I]
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	DISASTER MANAGEMENT	L	T	P	C
21DAC101b		2	0	0	0
	Semester	I			

Course Objectives: This course will enable students:

- Learn to demonstrate critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Critically evaluatedisasterriskreduction and humanitarian response policy and practice from
- Multiple perspectives.
- Developanunderstandingofstandardsofhumanitarianresponseandpracticalrelevanceinspecific types of disasters and conflict situations
- Criticallyunderstandthestrengthsandweaknessesofdisastermanagementapproaches,planningand programming in different countries, particularly their home country or the countries they work in

UNIT - I

Introduction:
Disaster:Definition,FactorsandSignificance;DifferenceBetweenHazardandDisaster;Naturaland Manmade Disasters: Difference, Nature, Types and Magnitude.
Disaster Prone Areas in India:
Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post- Disaster Diseases and Epidemics

UNIT - II

Repercussions of Disasters and Hazards:
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes,Volcanisms,Cyclones,Tsunamis,Floods,DroughtsandFamines,Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT - III

Disaster Preparedness and Management:
Preparedness: Monitoring of Phenomena Triggering ADisasteror Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT - IV

Risk Assessment Disaster Risk:
Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. TechniquesofRiskAssessment,GlobalCo-OperationinRiskAssessmentand Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT - V

Disaster Mitigation:
Meaning,ConceptandStrategiesofDisasterMitigation,EmergingTrendsInMitigation.Structural Mitigationand Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Suggested Reading

1. R.Nishith,SinghAK,"DisasterManagementinIndia:Perspectives,issuesandstrategies
2. "'New Royal book Company..Sahni,PardeepEt.Al.(Eds.),"DisasterMitigationExperiencesAndReflections",PrenticeHall OfIndia, New Delhi.
3. GoelS.L.,DisasterAdministrationAndManagementTextAndCaseStudies",Deep&Deep Publication Pvt. Ltd., New Delhi

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	**SANSKRITFOR TECHNICAL KNOWLEDGE**	**L**	**T**	**P**	**C**
21DAC101c		**2**	**0**	**0**	**0**
	Semester	**I**			

Course Objectives: This course will enable students:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- LearningofSanskrittodevelopthelogicinmathematics,science&othersubjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge
- Knowledge from ancientliterature

Course Outcomes (CO): Student will be able to

- Understanding basic Sanskrit language
- Ancient Sanskrit literature about science &technology can be understood
- Being a logical language will help to develop logic in students

UNIT - I		
Alphabets in Sanskrit,		
UNIT - II		
Past/Present/Future Tense, Simple Sentences		
UNIT - III		
Order, Introduction of roots		
UNIT - IV		
Technical information about Sanskrit Literature		
UNIT - V		
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics		

Suggested Reading

1.“Abhyaspustakam” –Dr.Vishwas, Sanskrit-Bharti Publication, New Delhi
2.“Teach Yourself Sanskrit” Prathama Deeksha- VempatiKutumbshastri, RashtriyaSanskrit Sansthanam, New Delhi Publication
3.“India’s Glorious ScientificTradition” Suresh Soni, Ocean books (P) Ltd.,New Delhi

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AUDIT COURSE-II

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	PEDAGOGY STUDIES	L	T	P	C
21DAC201a		2	0	0	0
	Semester	II			

Course Objectives: This course will enable students:

- Reviewexistingevidenceonthereviewtopictoinformprogrammedesignandpolicy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes (CO): Student will be able to

- Students will be able to understand:
- Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what
- conditions, and with what population of learners?
- Howcanteachereducation(curriculumandpracticum)andtheschoolcurriculumand guidance materials best support effective pedagogy?

UNIT - I

Introduction and Methodology: Aims and rationale, Policy back ground, Conceptual frame work and terminology Theories oflearning,Curriculum,Teachereducation.Conceptualframework,Research questions. Overview of methodology and Searching.

UNIT - II

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

UNIT - III

Evidence on theeffectivenessofpedagogicalpractices,Methodologyfortheindepthstage:quality assessmen t of included studies. How can teacher education (curriculumandpracticum) andthescho curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of th body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT - IV

Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head
teacherandthecommunity.Curriculumandassessment,Barrierstolearning:limitedresourcesand large class sizes

UNIT - V

Researchgapsandfuturedirections:Researchdesign,Contexts,Pedagogy,Teachereducation, Curriculum and assessment, Dissemination and research impact.

Suggested Reading

1. AckersJ,HardmanF(2001)ClassroominteractioninKenyanprimaryschools,Compare, 31 (2): 245-261.
2. AgrawalM(2004)Curricularreforminschools:Theimportanceofevaluation,Journalof
3. Curriculum Studies, 36 (3): 361-379.
4. AkyeampongK(2003) Teacher training in Ghana - does it count? Multi-site teachereducation research project (MUSTER) country report 1. London: DFID.
5. Akyeampong K, LussierK, PryorJ, Westbrook J (2013)Improving teaching and learning of basic maths and reading in Africa: Does teacherpreparation count?International Journal Educational Development, 33 (3): 272–282.
6. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education.

Oxford and Boston: Blackwell.
Chavan M (2003)ReadIndia: A mass scale, rapid, 'learning to read'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

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COURSE STRUCTURE & SYLLABI

Course Code	**STRESSMANAGEMENT BY YOGA**	**L**	**T**	**P**	**C**
21DAC201b		**2**	**0**	**0**	**0**
	Semester	**II**			

Course Objectives: This course will enable students:

- To achieve overall health of body and mind
- To overcome stres

Course Outcomes (CO): Student will be able to

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

UNIT - I		
Definitions of Eight parts of yog.(Ashtanga)		
UNIT - II		
Yam and Niyam.		
UNIT - III		
Do`sand Don't'sin life. i) Ahinsa,satya,astheya,bramhacharyaand aparigrahaii) Shaucha,santosh,tapa,swadhyay,ishwarpranidhan		
UNIT - IV		
Asan and Pranayam		
UNIT - V		
i)Variousyogposesand theirbenefitsformind &body ii)Regularizationofbreathingtechniques and its effects-Types ofpranayam		

Suggested Reading

1.'Yogic Asanas forGroupTarining-Part-I": Janardan SwamiYogabhyasiMandal, Nagpur
2."Rajayogaor conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	PERSONALITY DEVELOPMENT THROUGHLIFE ENLIGHTENMENTSKILLS	L	T	P	C
21DAC201c		2	0	0	0
	Semester	II			

Course Objectives: This course will enable students:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

Course Outcomes (CO): Student will be able to

- StudyofShrimad-Bhagwad-Geetawillhelpthestudentindevelopinghispersonalityand achieve the highest goal in life
- The person who has studied Geetawilllead the nation and mankind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students

UNIT - I

Neetisatakam- Holistic development of personality
Verses-19,20,21,22(wisdom)
Verses-29,31,32(pride &heroism)
Verses-26,28,63,65(virtue)

UNIT - II

Neetisatakam- Holistic development of personality
Verses-52,53,59(dont's)
Verses-71,73,75,78(do's)

UNIT - III

Approach to day to day work and duties.
ShrimadBhagwadGeeta:Chapter2-Verses41,47,48,
Chapter3-Verses13,21,27,35,Chapter6-Verses5,13,17,23,35,
Chapter18-Verses45,46,48.

UNIT - IV

Statements of basic knowledge.
ShrimadBhagwadGeeta:Chapter2-Verses 56,62,68
Chapter12 -Verses13,14,15,16,17,18
Personality of Rolemodel. Shrimad Bhagwad Geeta:

UNIT - V

Chapter2-Verses 17,Chapter3-Verses36,37,42,
Chapter4-Verses18,38,39
Chapter18– Verses37,38,63

Suggested Reading

1."SrimadBhagavadGita"bySwamiSwarupanandaAdvaitaAshram(PublicationDepartment), Kolkata
2.Bhartrihari'sThree Satakam (Niti-sringar-vairagya) by P.Gopinath, RashtriyaSanskrit Sansthanam, New Delhi.

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
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OPEN ELECTIVE

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	BUSINESS ANALYTICS	L	T	P	C
21DOE301c		3	0	0	3
Semester		III			

Course Objectives:

- The main objective of this course is to give the student a comprehensive understanding of business analytics methods.

Course Outcomes (CO): Student will be able to

- Students will demonstrate knowledge of data analytics.
- Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
- Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
- Students will demonstrate the ability to translate data into clear, actionable insights.

UNIT - I — Lecture Hrs:

Business Analysis: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst.
Stakeholders: the project team, management, and the front line, Handling Stakeholder Conflicts.

UNIT - II — Lecture Hrs:

Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.

UNIT - III — Lecture Hrs:

Forming Requirements: Overview of Requirements, Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modeling, Business Process Modeling

UNIT - IV — Lecture Hrs:

Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements. Managing Requirements Assets: Change Control, Requirements Tools

UNIT - V — Lecture Hrs:

Recent Trands in: Embedded and colleborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.

Textbooks:

1. Business Analysis by James Cadle et al.
2. Project Management: The Managerial Process by Erik Larson and, Clifford Gray

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

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COURSE STRUCTURE & SYLLABI

Course Code	**INTERNET OF THINGS (IOT)**	**L**	**T**	**P**	**C**
21DOE301g		**3**	**-**	**-**	**3**
	Semester	**III**			

Course Objectives: Student will be able

- To study fundamental concepts of IoT
- To understand roles of sensors in IoT
- To Learn different protocols used for IoT design
- To be familiar with data handling and analytics tools in IoT
- Appreciate the role of big data, cloud computing and data analytics in a typical IoT system

Course Outcomes (CO): Student will be able to

- Understand the various concepts, terminologies and architecture of IoT systems.
- Use sensors and actuators for design of IoT.
- Understand and apply various protocols for design of IoT systems
- Use various techniques of data storage and analytics in IoT
- Understand various applications of IoT
- Understand APIs to connect IoT related technologies

UNIT – I	Lecture Hrs:09

Fundamentals of IoT: Introduction, Definitions & Characteristics of IoT, IoT Architectures, Physical & Logical Design of IoT, Enabling Technologies in IoT, History of IoT, About Things in IoT, The Identifiers in IoT, About the Internet in IoT, IoT frameworks, IoT and M2M

UNIT – II	Lecture Hrs: 09

Sensors Networks : Definition, Types of Sensors, Types of Actuators, Examples and Working, IoT Development Boards: Arduino IDE and Board Types, RaspberriPi Development Kit, RFID Principles and components, Wireless Sensor Networks: History and Context, The node, Connecting nodes, Networking Nodes, WSN and IoT.

UNIT – III	Lecture Hrs: 09

Wireless Technologies for IoT: WPAN Technologies for IoT: IEEE 802.15.4, Zigbee, HART, NFC, Z-Wave, BLE, Bacnet, Modbus.
IP Based Protocols for IoT IPv6, 6LowPAN, RPL, REST, AMPQ, CoAP, MQTT. Edge connectivity and protocols

UNIT – IV	Lecture Hrs: 09

Data Handling& Analytics: Introduction, Bigdata, Types of data, Characteristics of Big data, Data handling Technologies, Flow of data, Data acquisition, Data Storage, Introduction to Hadoop. Introduction to data Analytics, Types of Data analytics, Local Analytics, Cloud analytics and applications

UNIT - V	Lecture Hrs: 09

Applications of IoT: Home Automation, Smart Cities, Energy, Retail Management, Logistics, Agriculture, Health and Lifestyle, Industrial IoT, Legal challenges, IoT design Ethics, IoT in Environmental Protection.

Textbooks:

1.Hakima Chaouchi, — "The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Wiley Publications
2.Olivier Hersent, David Boswarthick, and Omar Elloumi, — "The Internet of Things: Key Applications and Protocols", WileyPublications
3.Vijay Madisetti and ArshdeepBahga, — "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014.
4.J. Biron and J. Follett, "Foundational Elements of an IoT Solution", O'Reilly Media, 2016.
5.Keysight Technologies, "The Internet of Things: Enabling Technologies and Solutions for Design

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COURSE STRUCTURE & SYLLABI

and Test", Application Note, 2016.
Reference Books:
1.Daniel Minoli, — "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publication 2.Pethuru Raj and Anupama C. Raman, "The Internet of Things: EnablingTechnologies, Platforms, and Use Cases", CRC Press
Online Learning Resources:
https://onlinecourses.nptel.ac.in/noc17_cs22/course http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

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M.TECH. IN PRODUCTION ENGINEERING AND ENGINEERING DESIGN
COURSE STRUCTURE & SYLLABI

Course Code	**MECHATRONICS**	**L**	**T**	**P**	**C**
21DOE301h		**3**	**0**	**0**	**3**
	Semester	**III**			

Course Objectives: Student will be able

- To study fundamental concepts of Signal condition
- To understand the concepts of precision mechanical systems
- To Learn different electronic interface subsystems
- To be familiar with microcontrollers overview.
- To understand the concepts of programmable logic controllers

Course Outcomes (CO): Student will be able to

- Understand the various concepts, terminologies of Signal condition
- Understand the basics electronic interface subsystems
- Understand and apply various precision mechanical systems
- Understand various applications of microcontrollers overview
- Understand the controlling of programmable logic and programmable motion.

UNIT – I		Lecture Hrs:09

INTRODUCTION : Definition – Trends - Control Methods: Standalone , PC Based (Real Time Operating Systems, Graphical User Interface , Simulation) - Applications: SPM, Robot, CNC, FMS, CIM.

SIGNAL CONDITIONING : Introduction – Hardware - Digital I/O, Analog input – ADC, resolution , speed channels Filtering Noise using passive components – Resistors, capacitors - Amplifying signals using OP amps – Software - Digital Signal Processing – Low pass , high pass , notch filtering.

UNIT – II		Lecture Hrs: 09

PRECISION MECHANICAL SYSTEMS : Pneumatic Actuation Systems - Electro-pneumatic Actuation Systems - Hydraulic Actuation Systems - Electro-hydraulic Actuation Systems - Timing Belts – Ball Screw and Nut - Linear Motion Guides - Linear Bearings - Harmonic Transmission - Bearings- Motor / Drive Selection.

UNIT – III		Lecture Hrs: 09

ELECTRONIC INTERFACE SUBSYSTEMS : TTL, CMOS interfacing - Sensor interfacing – Actuator interfacing – solenoids , motors Isoation schemes- opto coupling, buffer IC's - Protection schemes – circuit breakers , over current sensing , resetable fuses , thermal dissipation - Power Supply - Bipolar transistors / mosfets

ELECTROMECHANICAL DRIVES : Relays and Solenoids - Stepper Motors - DC brushed motors – DC brushless motors - DC servo motors - 4-quadrant servo drives , PWM's - Pulse Width Modulation – Variable Frequency Drives, Vector Drives - Drive System load calculation

UNIT – IV		Lecture Hrs: 09

MICROCONTROLLERS OVERVIEW: 8051 Microcontroller , micro processor structure - DigitalInterfacing - Analog Interfacing - Digital to Analog Convertors - Analog to Digital Convertors - Applications. Programming –Assembly , C (LED Blinking , Voltage measurement using ADC).

UNIT - V		Lecture Hrs: 09

PROGRAMMABLE LOGIC CONTROLLERS : Basic Structure - Programming : Ladder diagram -Timers, Internal Relays and Counters - Shift Registers - Master and Jump Controls - Data Handling - Analog input / output - PLC Selection - Application.

PROGRAMMABLE MOTION CONTROLLERS : Introduction - System Transfer Function – Laplace transform and its application in analysing differential equation of a control system - Feedback Devices :Position , Velocity Sensors - Optical Incremental encoders - Proximity Sensors : Inductive , Capacitive ,

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Textbooks:
1. A text book of Mechatronics by Er.R.K. RAJPUT ., S.CHAND publications 2. A text book of Mechatronics by Nitalgour Premchand Mahalik ., McGraw Hill publications
Reference Books:
1. A text book of Mechatronics by W.Bolton ., Pearson Publications