DEPARTMENT OF MECHANICAL ENGINEERING

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR -713209

Course on MASTER OF TECHNOLOGY

Specialization: Machine Design

FULL TIME

Sl. No.	Subject Code	Name of the Subject	L	T	P	CP
Semester I						
1.	ME 1001	Machine Dynamics and Control	3	1	0	4
2.	ME 1002	Advanced Mechanics of Solids	3	1	0	4
3.	ME 1003	Kinematic Analysis and Synthesis of Mechanisms	3	1	0	4
4.	ME 90**	Elective-I	3	1	0	4
5.	ME 90**	Elective-II	3	1	0	4
6.	ME 1051	**Dynamics Laboratory**	0	0	4	2
7.	ME 1052	Applied Computational Methods Lab	0	0	4	2
					Total Credit	**24**
Semester II						
1.	ME 2001	Advanced Machine Design	3	1	0	4
2.	ME 2002	Advanced Mechanical Vibrations	3	1	0	4
3.	ME 2003	Theory of Elasticity and Plasticity	3	1	0	4
4.	ME 90**	Elective-III	3	1	0	4
5.	ME 90**	Elective-IV	3	1	0	4
6.	ME 2051	Computer Aided Design Laboratory	0	0	4	2
7.	ME 2052	Seminar –I (Non Project)	0	0	2	1
8.	ME 2053	Project-I	0	0	2	1
					Total Credit	**24**
Semester III						
1.	ME 3051	Project-II				11
2.	ME 3052	Project Seminar-I				2
					Total Credit	**13**
Semester IV						
1.	ME 4051	Project-III				11
2.	ME 4052	Project Seminar-II and Viva-Voce				3
					Total Credit	**14**
					TOTAL CREDIT POINT : 75	

List of Electives

LIST OF ELECTIVE SUBJECTS		
Sl. No.	**Subject Code**	**Name of the Subject**
1.	ME 9011	Applied Computational Methods
2.	ME 9012	Introduction to Non-linear Dynamic Systems and Control
3.	ME 9013	Theory of Plates and Shells
4.	ME 9014	Operation Research
5.	ME 9015	Fracture Mechanics
6.	ME 9016	Mechatronics
7.	ME 9017	Experimental Stress Analysis
8.	ME 9018	Finite Element Methods
9.	ME 9019	Robotics
10.	ME 9020	Knowledge Based Systems
11.	ME 9021	Design for Manufacturing and Assembly
12.	ME 9022	Modern Manufacturing Processes
13.	ME 9023	Computer Aided Design
14.	ME 9024	Mechanics of Composite and Functionally Graded material
15.	ME 9025	Modelling and Simulation of Mechanical Systems
16.	ME 9026	Tribology
17.	ME 9027	Product Design
18.	ME 9028	Material Handling Equipments
19.	ME 9029	Optimization in Engineering Design
20.	ME 9030	Design of Machine Tools

SYLLABUS

Department of Mechanical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 1001	**Machine Dynamics and Control**	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Mechanics and Theory of Machines		CT+EA					
Course Outcomes	CO1: Students will be able to formulate the procedure for modeling various types of Machines and/ or its components CO2: Students will learn to study the performance of various systems with respect to time						

	and the procedure to improve. CO3: Students will learn to identify various types of coordinate frames required for describing the behavior of different mechanisms. CO4: Students will be able to formulate and evaluate behavior of linear time continuous control systems. CO5: Students will be able to identify and critically evaluate current developments and emerging trends within the field of control systems.	
Topics Covered	Generalized Forces and Coordinates, Lagrange's Equations Cam dynamics Balancing of rotors, Field balancing Rotor dynamics, Gyroscope: action and applications System Modeling, Block diagrams, Transfer functions Dynamic response of systems Structure of Control systems and Control Laws PID control - principle and design Stability criteria – Frequency response plot Root locus plot analysis State-space representations	6 4 4 6 2 3 3 3 3 3 4
Text Books, and/or reference material	**Text Books:** 1. Theory of Mechanisms and Machines, Ghosh, Mallik 2. Modern Control Engineering, Ogata **Reference Books** 1. Theory of Machines and Mechanisms, Shigley, Uicker 2. Automatic Control System, Kuo	

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 1002	**Advanced Mechanics of Solids**	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Solid Mechanics Course in B. Tech level		CT+EA					
Course Outcomes	CO1: Student will learn about 3-D state of stress and strain CO2: Student will learn to derive governing equations related to solid mechanics. CO3: Student will be able to sole various critical engineering problems related to solid mechanics like beam on elastic foundation, curved beam, plate bending and stability problem						
Topics Covered	Introduction (2) Stress and Strains in 3-D – Cauchy formula, Principal Stress, hydrostatic stress, deviatoric stress, Mohr circle, octahedral stresses, principal strain, plane state of stress, plane state of strain etc. (10) Theories of failure (4) Beam on elastic foundations (4) Bending of curved beams – Crane Hooks & Chains (4) Bending of thin plates(Equation for thin rectangular and circular plates, Navier's and						

	Levy's solution for rectangular plates) (6) Elastic stability, Euler's buckling load, Beam column for various load (4) Unsymmetrical bending, shear centre (6)
Text Books, and/or reference material	**Text Books:** 1. Advanced Mechanics of Solids, L. S. Srinath 2. Advanced Strength of Materials, J. P. Denhartog 3. Advance Mechanics of Materials, A. P. Boresi & R. J. Schmidt
	Reference Books: 1. Advanced Mechanics of Solids, Otto T. Bruhns 2. Solid Mechanics, Clive L. Dym, Irving H. Shames 3. Solid Mechanics, Kazimi

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 1003	**Kinematic Analysis and Synthesis of Mechanisms**	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Engineering Mechanics, Theory of Machine		CT+EA					
Course Outcomes	CO1: Students will be able to understand the need of multi-body mechanics CO2: Students will be able to formulate and evaluate kinematic behavior of different mechanisms CO3: Students will be able to synthesize and analyze the multi-body systems involving different types of mechanisms.						
Topics Covered	Introduction to mechanisms: Kinematic pairs, kinematic chains, planar mechanisms, spatial mechanisms, equivalent mechanism, kinematic inversion, mobility, transmission angle, deviation angle etc. (3) Kinematic analysis of mechanisms: displacement, velocity and acceleration analysis of planar mechanisms and spatial mechanisms. (8) Synthesis of Planar mechanisms: Type synthesis, number synthesis, dimensional synthesis, Chebyshev polynomials, Freudenstein's displacement equation. (5) Dimensional synthesis- Different types of synthesis methods e.g. algebraic methods, complex numbers method, Bloch's method etc. (7) Coupler-curve synthesis and cognate linkages. (4) Introduction to dimensional synthesis of spatial mechanisms. (4) Analysis and synthesis of Cams. (9)						
Text Books, and/or reference material	**Text Books:** 1. Kinametic Analysis and Synthesis by Mallik, Ghosh, Dittrich 2. Kinametic Synthesis of Linkages, Hartenberg, Denavit						
	Reference Books: 1. Theory of Machines and Mechanisms, Uicker, Pennock, Shigley 2. Advanced Mechanism Design: Analysis & Synthesis, Sandor, Erdman						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 1051	**Dynamics Laboratory**	PCR	**0**	**0**	**4**	**4**	**2**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
ME 1001		CT+EA					
Course Outcomes	CO1: Acquire basic idea about the rotor balancing CO2: Apply different control laws						
Topics Covered	Experiment on rotor balancing 12 Experiment on Gyroscope 12 Experiment on Digital Pendulum System 8 Experiment on Twin Rotor MIMO System 8 Problems as assigned by the respective teachers 16						
Text Books, and/or reference material	**Text Books:** 1. Theory of Mechanisms and Machines, Ghosh, Mallik 2. Modern Control Engineering, Ogata						
	Reference Books 1. Theory of Machines and Mechanisms, Shigley, Uicker 2. Automatic Control System, Kuo						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME1052	**Applied Computational Methods Lab**	PCR	**0**	**0**	**4**	**4**	**3**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Applied Computational Methods		CT+EA					
Course Outcomes	CO1: Students will get idea of different programming languages CO2: Students will learn to develop algorithm for different problems CO3: Students will learn to write computer program to solve different engineering problems using various numerical methods						
Topics Covered	Introduction to programming using high level language (C/C++/Fortran/MATLAB) Computer programming for solving linear simultaneous equations, non-linear equations Numerical differentiation and integration Solution of ordinary differential equations and solution of partial differential equations Eigen value problems, Boundary value, Initial value problems Problems as assigned by the respective teachers						
Text Books, and/or reference material	**Text Books:** 1. Mat Lab Programming for Engineers By S. J. Chapman 2. Getting started with Mat lab By Rudra Pratap 3. Computer Programming in Fortran 90 and 95 by Rajaraman						
	Reference Books: **1.** Numerical Methods By B. S. Grewal 2. Numerical Recipes in Fortran By W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P. Flannery						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 2001	**Advanced Machine Design**	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Advanced Mechanics of Solids		CT+EA					
Course Outcomes	CO1: Students will be able to identify the significant loads on various Machine Components CO2: Students will learn types of Lubrication methods and various design aspects of sliding contact bearings. CO3: Students will learn to visualize the stress in machine components having complicated shape. CO4: Students will be able to design machine components for given lifespan and also predict damage that can occur during its. CO5: Students will be able to understand the functioning of gears and the concept of maximum load that can appear on such gears and methods to be adopted for improving the life of gears.						
Topics Covered	Hydrodynamic Lubrication of Sliders and Bearings, Long and Short Bearings, Pressure distribution, Oil film thickness, Load carrying capacity, Friction and heating of journal bearing. Torsion of noncircular shafts. Press fitted assemblies and rotating discs. Fatigue strength, Fluctuating loads, Cumulative fatigue damage. Contact stresses. Dynamic load on gears						10 6 10 6 4 4 4
Text Books, and/or reference material	Text Books: 1.Introduction to Tribology , B. C. Majumder 2. Advanced Strength of Materials, Seely, Smith Reference Books 1. Analytical Mechanics for Gear, E. Buckingham 2. Analysis of Mechanical Design, A. Burr						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 2002	**Advanced Mechanical Vibration**	**PCR**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Fundamentals of Vibrations		CT+EA					
Course Outcomes	CO1: Understanding the fundamental material for a modern treatment of vibrations. CO2: Application of Lagrange equations for lumped and continuous systems CO3: Understanding fundamentals of beam theory; extensional, torsional, and flexural vibrations of beams.						

	CO4: Understanding Self-excited vibration, nonlinear vibration etc.
Topics Covered	Review of relevant mathematics: linear algebra (3) Generalized co-ordinates, Lagrange's equations (3) Single-DOF and multi-DOF vibration (7) Vibration Absorber (2) Torsional vibration (4) Periodic excitation and Fourier series, impulse and step response (5) Vibration in continuous systems (4) Self-excited vibration, Criterion of stability; Effect of friction (5) Introduction to nonlinear vibration (7)
Text Books, and/or reference material	**Suggested Text Books:** 1. Mechanical Vibrations, S. S. Rao, Pearson Education Inc. (4th Ed.), 2007. 2. Fundamental of Vibrations Leonard Meirovitch, Mc-Graw Hill Inc., 2001 3. Vibration and Control, D. J. Inman, John Willey & Sons Inc, 2002 **Reference Books:** 1. Mechanical Vibrations, S. Tamadonni & Graham S. Kelly, Schaum's Out line Series, Mc-Graw Hill Inc, 1998. 2. Vibration Condition Monitoring of Machines, J. S. Rao, Tata Mc-Graw Hill, 2006

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 2003	**Theory of Elasticity and Plasticity**	**PCR**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Machine design and production engineering courses in any B.Tech Mechanical Engineering Program.					
Strength of Materials		CT+EA					
Course Outcomes		CO1: Students will be able to identify the importance of use of properties of Plasticity and Elasticity. CO2: Students will be able to gather knowledge about mechanics of different materials.					
Topics Covered		Scalar, Vector, Matrix, and Tensor definition, Index notation, Kronecker Delta and alternating Symbol, Coordinate transformation. (2) Strain Energy and related Principles, Principle of Virtual work, Principle of Minimum Potential Energy and Complementary Energy, Rayleigh-Ritz Method. (8) Stress-Strain relations for anisotropic materials, Basic Cases of Elastic Symmetry, Laminates, Ply stress and ply strain, Micromechanics of Composites. Basic concepts of nonhomogeneous elasticity, Uniaxial tension of a graded sheet, plane problem of a hollow cylinder (made of graded material) under uniform pressure. (12) Thermal stresses in bars, Thermal bending of beam, Basic equation of Thermo elasticity. (2) Introduction to plasticity: Fundamentals of plastic deformation, Theories of failure and yield criteria of metals. (6) Mechanics of metal forming processes - forging, rolling, drawing, bending, and extrusion. Friction and lubrication in metal forming processes. Defects in metal working. (12)					
Text Books, and/or reference		Text Books: 1. Theory of Elasticity, Timoshenko and Goodier 2. Engineering Plasticity: Theory and application to metal forming Processes, R. A. C.					

material	Slater
	Reference Books: 1. Applied Plasticity, J. Chakrabarty

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 2051	**Computer Aided Design Laboratory**	**PCR**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	CO1: Ability to create fully constrained solid models using standard CAE software tools CO2: Ability to create and edit engineering drawings with tolerances (both part and assemblies) using standard CAE software tools CO3: Ability to handle 3D printers.						
Topics Covered	1. Demonstration of standard features of CAE software tools - [12 Hours] 2. Generation of 2D and 3D part drawings for various machine componenets – [12 Hours] 3. Assembly Modeling - [8Hours] 4. Dimensioning and Tolerances in engineering drawing – [8Hours] 5. Preparation of prototypes using 3D printers – [8Hours]						
Text Books, and/or reference material	**Text Books** • Martenson, E. Micheal, Geometric Modelling, John Wiley & Sons, 1995. • Zeid Ibrahim.1998. CAD/CAM Theory and Practice. Tata McGraw Hill. • Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientificpublications , Third Edition, 2010. • Manuals of CAE Software tools						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 2052	Seminar –I (Non Project)	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NA		CT+EA					
Course Outcomes	CO1: To be able to conduct review of literature to arrive at selected advances topic for seminar.						

	CO2: To be able to summaries the concept of the chosen topic systematically after considerable study of the content from primary as well as secondary sources CO3: To be able to write and present a technical report with suitable conclusion as per international standards CO4: To be able to discuss and depend the outcome of the report in a seminar
Topics Covered	Seminar –I (Non Project): Topics decided by consultation with the supervisor
Text Books, and/or reference material	**Text Books:**
	Reference Books:

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 2053	Project –I	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NA		CT+EA					
Course Outcomes	CO1: Ability to interpret ideas and thoughts into practice in a project. CO2: Ability to analyze the gap between theoretical and practical knowledge. CO3: Ability to compose technical presentation in the conferences and Journals.						
Topics Covered	Project as decided based on literature survey with consultation with the supervisor						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 3051	Project –II	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NA		CT+EA					
Course Outcomes	CO1: Ability to interpret ideas and thoughts into practice in a project. CO2: Ability to analyze the gap between theoretical and practical knowledge. CO3: Ability to compose technical presentation in the conferences. CO4: Ability to prepare for publishing papers in journals. CO5: Ability to propose for the patent rights for the projects.						
Topics Covered	Project as decided based on literature survey with consultation with the supervisor						
Department of Mechanical Engineering							
Course Code	Title of the course	Program Core (PCR) /	Total Number of contact hours				Credit
			Lecture	Tutorial	Practical	Total	

		Electives (PEL)	(L)	(T)	(P)	Hours	
ME 3052	Project Seminar -I	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NA		CT+EA					
Course Outcomes	CO1: To be able to conduct review of literature to arrive at selected advances topic for seminar. CO2: To be able to summaries the concept of the chosen topic systematically after considerable study of the content from primary as well as secondary sources CO3: To be able to write and present a technical report with suitable conclusion as per international standards CO4: To be able to discuss and depend the outcome of the report in a seminar						
Topics Covered	Project seminar: Progress of the project						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 4051	Project -III	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NA		CT+EA					
Course Outcomes	CO1: Ability to interpret ideas and thoughts into practice in a project. CO2: Ability to analyze the gap between theoretical and practical knowledge. CO3: Ability to compose technical presentation in the conferences. CO4: Ability to prepare for publishing papers in journals. CO5: Ability to propose for the patent rights for the projects.						
Topics Covered	Project as decided based on literature survey with consultation with the supervisor						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 4052	Project seminar II and Viva-voce	PCR	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NA		CT+EA					
Course Outcomes	CO1: Ability to assess knowledge in the subject and the project. CO2: Ability to integrate technical question through all the years of study. CO3: Ability to express and communicate.						

	CO4: Ability to evaluate technical confidence. CO5: Ability to improve communication. CO6: Ability to validate the knowledge gained through years of study.
Topics Covered	Project seminar II and Viva-voce

Electives

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9011	**Applied Computational Methods**	PEL	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Engineering Mathematics in B. Tech Level		CT+EA					
Course Outcomes	CO1: Students will be able to understand common numerical methods and how they are used to obtain approximate solutions. CO2: Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations. CO3: Analyze and evaluate the accuracy of common numerical methods.						
Topics Covered	Solution of linear simultaneous equations, matrix Inversion (6) Solution of non-linear equation of one variable and solution of system of non-linear simultaneous equation (6) Interpolation and curve fitting (4) Numerical differentiation and integration (4) Solution of ordinary differential equations and solution of partial differential equations (4) Discrete and Fast Fourier transformation (5) Analysis of Eigen value problems (4) Application to different types of Boundary value, Initial and Eigen value problems (4) Brief discussion on software for numerical solution (2)						
Text Books, and/or reference material	**Text Books:** 1. Advanced Engineering Mathematics, E. Kreyszig 2. Numerical Methods for Scientist and Engineers, R. W. Hamming 3. Applied Mathematics for Engineers and Physicists By Pipes and Harvill						
	Reference Books: 1. Introduction to Numerical Analysis, F. B. Hildebrand 2. Fundamentals of Engineering Numerical analysis, P. Moin						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9012	**Introduction to Non-linear dynamic Systems and Control**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites Nonlinear Vibrations		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Mechanical Vibrations		CT+EA					
Course Outcomes	CO1: Understanding the various characteristics of nonlinear dynamic system. CO2: Development of solution procedures employing approximate methods. CO3: Develop the concept of stability and different methods for stability and bifurcation analysis. CO4: Analysis of nonlinear system employing numerical techniques and comparing the results with approximate methods.						
Topics Covered	Introduction, General properties of nonlinear systems, Phase plane analysis, Equilibrium solutions, Active and feedback concepts for control (4) Well-developed analytical/semi-analytical and numerical methods for analysis (12) Study of periodic, sub-harmonic, super-harmonic and chaotic motions of uncontrolled and controlled nonlinear dynamic systems (9) Definition of stability, Stability of linear systems, Stability of nonlinear systems, Liapunov theorems, frequency domain criteria, stability of fixed points, stability of periodic solutions (9) Control of periodic, sub-harmonic, super-harmonic and chaotic motions (10)						
Text Books, and/or reference material	Suggested Text Books: 1. Nayfeh, A. H., and Mook, D. T., Nonlinear Oscillations, Wiley-Interscience, 1979. 2. Hayashi, C. Nonlinear Oscillations in Physical Systems, McGraw-Hill, 1964. Reference Books: 1. Nonlinear Ordinary Differential Equations: An Introduction for Scientists and Engineers, D. Jordon and P. Smith, Oxford 2. Evan-Ivanowski, R. M., Resonance Oscillations in Mechanical Systems, Elsevier. 3. Nayfeh, A. H., and Balachandran, B., Applied Nonlinear Dynamics, Wiley. 4. Seydel, R., From Equilibrium to Chaos: Practical Bifurcation and Stability Analysis, Elsevier.						

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			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9013	**Theory of Plates and Shells**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Advanced Mechanics of Solids		CT+EA					
Course Outcomes	CO1: Students will be able to use different theories to plate and shell CO2: Students will be able to use Theory of virtual displacement to get governing						

	equation of different structural members like beams, plates shells etc. CO3: Students will be able to solve different plate, shell problems using analytically and numerically
Topics Covered	Stress strain relations, strain displacement relation, equations of equilibrium, virtual work principle, Classical plate theory, FSDT, HSDT. (6) Pure bending and cylindrical bending of isotropic rectangular plates, Navier and Levy solutions of rectangular plates (6) Bending of circular plates (4) Bending analysis of laminated composites plates (6) Approximate solution methods for plate problems (6) Dynamics of Plates (3) Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells (9)
Text Books, and/or reference material	**Text Books:** 1. Theory of Plates and Shells, S. Timoshenko 2. Theory and Analysis of Elastic Plates and Shells, J. N. Reddy
	Reference Books: 1. Mechanics of Laminated Composite Plates and Shells Theory and Analysis, J. N. Reddy 2. Theories and Applications of Plate Analysis, R. Szilard 3. Plates Theory and Applications By K. Bhaskar and T. K. Varadan

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9014	**Operation Research**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Advanced Mechanics of Solids		CT+EA					
Course Outcomes	CO1: Students will be able to discuss the history, concepts, formulations and applications of operations research. CO2: Students will be able to analyze and solve conflicting problems on constrained linear optimization problems having single and multiple objectives. CO3: Students will be able to apply integer, dynamic programming methods for solving relevant problems.						
Topics Covered	Origin, growth, definition, methodology and application of OR Linear Programming, Mathematical Modeling, Graphical Method of Solution, Sensitivity Analysis Simplex Method, Big M and 2-Phase Methods, Duality in LP Transportation problem, Assignment Problem, Sequencing problem Queuing model and Simulation Competitive Decision Making, Game Theory Duality Theory and Sensitivity Analysis Integer Programming, Binary Integer Programming Integer Programming, Binary Integer Programming						

	Dynamic Programming
Text Books, and/or reference material	**Text Books:** 1. Introduction to Operations Research, Fredrick S. Hillier and erald J. Lieberman, 7th Edition, TMH, 2001 2. Industrial Engineering and Management-- O.P.Khanna 3. Operation Research for Engineers-- S.K.Basu, D.K.Pal, H.Bagchi 4. Operation Research: an Introduction-- D.S.Hira, P.K.Gupta
	Reference Books: 1. Introduction to Operation Research-- C.M.Churchman, R.L.Aekaff, E.L.Arnoff 2. Operation Research in Production and Inventory Control-- F.Hanssmann

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9015	**Fracture Mechanics**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Advanced Mechanics of Solids		CT+EA					
Course Outcomes							
Topics Covered	Brief review: Strength, stiffness and toughness properties of materials, principles of elasticity and plasticity, stress concentration. Different modes of crack opening, Stresses and displacement around the stationary crack under static load. Irwin' approach, crack closure and strain energy release rate approach, stress intensity approach, compliance approach and energetics and J-integral. Effects of small-scale yielding, thickness and plastic energy dissipation. Fracture criteria in mixed mode fracture and effect of mixed-mode plasticity. Initiation and propagation of crack and its stability, Propagation of crack under fatigue load and effect of residual stresses. Experimental methods: different types of test specimens and testing procedures. Detection of cracks. Stress waves, dynamic nature of fracture, crack speed and crack arrest. Brief introduction to analytical and numerical methods in fracture mechanics. Effect of environment. Fracture control and design considerations.						3 7 4 4 6 4 6 4 2
Text Books, and/or reference material	**Text Books:** 1. Elementary Engineering Fracture Mechanics, D.Broek 2. Fundamentals of Fracture Mechanics, J.F.Knott						

	Reference Books: 1. Fracture Mechanics, S.K.Maiti

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9016	**Mechatronics**	PEL	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Machine Dynamics and Control		CT+EA					
Course Outcomes	CO1: Students will be able to identify the importance of amalgamation between the electronics and electro-mechanical systems. CO2: Students will be able to formulate and evaluate behavior of linear time continuous control systems. CO3: Students will be able to formulate the procedure for converting analog signals to digital form and vice-versa. CO4: Students will be able to describe signals and its processing by modern electronic methods. CO5: Students will be able to identify and critically evaluate current developments and emerging trends within the field of mechatronic systems.						
Topics Covered	Mechatronic Systems: Introduction, Application of Mechatronics. 2 Sensors and Transducers - Brief review, Simple electronic elements & Operational Amplifiers. 4 Actuators: Pneumatic, Hydraulic, Electrical & Mechanical actuation system, Micro-actuators. 6 Modelling and Simulation of Physical System: System models, Dynamic responses of the system, System transfer functions. 6 Digital logic: Number systems, Boolean algebra, Logic gates - Application gate, Design of logic of digital logic gates. 6 Microprocessors and Micro-Controllers: Introduction, Microprocessor Architecture, Instruction codes, General requirements for implementation issues, Examples. 6 Programmable Logic Controllers: Basic structure, I/O processing, Programming, Timer, Inter relays and Counters. 8 Signal conditioning & Digital communication system: Basics of signal conditioning, Filtering, Data acquisition and Digital signal processing, Digital communication and Communication interface. 8 Mechatronic Systems, Case Studies. 10						
Text Books, and/or reference material	**Text Books:** 1. Alciatore, D. G. and Histand, M. B., Introduction to Mechatronics and Measurement Systems, McGraw Hill Publications, 4th Edition, 2012. 2. Bolton, W., Mechatronics, Pearson Education India, 2008. 3. Gaonkar, R.S., Microprocessor Architecture, Programming and Applications with 8085, Penram Publishers India, 6th Edition, 2013.						
	Reference Books: 1. Malvino, A. P., and Bates, D. J., Electronic Principles, TMH Publishing Company Ltd., New Delhi, 8th Edition, 2016. 2. Nise, N. N., Control Systems Engineering, 6th Edition, John Wiley & Sons, Inc., USA, 2011.						

Department of Mechanical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9018	**Finite Element Methods**	PEL	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Advanced Mechanics of Solids		CT+EA					
Course Outcomes	CO1: Students will learn learn the theory and characteristics of finite elements that represent engineering structures like bar and beam. CO2: Students will be able to solve structural, thermal, dynamic problems. CO3: Students will be able to use computer to sole FEM problems.						
Topics Covered	Brief review of mathematical concept, Matrix, gauss elimination method, Eigenvalue solution, Numerical Integration, Weighted residual methods, calculus of variation and Rayleigh-Ritz method (6) Introduction to finite element methods: Direct approach for standard discrete system. Potential Energy approach and virtual work approach, Variational approach and Galerkin's weighted residual approach for continuum (6) Interpolation polynomial – Lagrangian and Hermite. Natural Co-ordinates, Pascal triangle, concept of continuity, convergence criteria (4) Common elements: Bar elements, beam elements, triangular Elements, rectangular elements etc. Lagrangian Elements and Serendipity Elements. Concept of iso-parametric elements (6) Concept of time-independent field problem and time independent field problem involving differential equations. Different types of Boundary conditions (6) Concept of mass matrix. Vibration problem and dynamic response problem (6) Introduction to geometric non-linearity and material non-linearity in finite element analysis (3) Computer procedure for finite element analysis (3)						
Text Books, and/or reference material	**Text Books:** 1. An Introduction to the Finite Element Method, J. N. Reddy 2. Finite Element Procedures By K. J. Bathe 3. Text book of Finite Element analysis, P. Seshu						
	Reference Books: 1. The Finite Element Method in Engineering, S. S. Rao 2. The Finite Element Method its Basis and Fundamental , O. C. zienkiewich, R. L. Taylor, J. Z. Zhu 3. The Finite Element Method in Engineering by S. S. Rao						

Department of Mechanical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9019	**Robotics**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					

Advanced Mechanics of Solids	CT+EA
Course Outcomes	CO1: Students will be able to discuss the history, concepts and key components of robotics technologies. CO2: Students will be able to analyze and solve problems spatial transformation, forward and inverse kinematics, dynamics of robot manipulators, Jacobian and singularities, joint trajectory for motion planning. CO3: Students will be able to describe and compare various robot grippers, sensors, actuators and controllers and their perception.
Topics Covered	Introduction to Robotics: Definition, Anatomy, Coordinate Systems, Work Envelopes, Basic structure, classification, applications of robots. Position kinematics of serial manipulators: Frame transformation, Denavit-Hartenberg convention, Forward manipulator kinematics, Inverse manipulator kinematics, Velocity and acceleration analysis of serial manipulators, Statics of serial manipulators Dynamics of serial manipulators: Lagrange-Euler formulation, Newton- Euler formulation Planning of Manipulator Trajectories: Joint space scheme, Cartesian space scheme, Robot end-effectors Fundamentals of Robot Drives and Actuators Robot Sensors: Contact type, non-contact type, internal sensor, External sensor, Range sensor, Proximity sensor; touch sensor, Force and torque sensor, Encoders, Robotic Vision etc.
Text Books, and/or reference material	**Text Books:** 1. Robotics, Fu, Lee, Gonzalez 2.Introduction to Robotics, S.K.Saha
	Reference Books: 1. Introduction to Robotics, J.J.Craig

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9020	Knowledge Based systems	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Advanced Mechanics of Solids		CT+EA					
Course Outcomes	CO1: Students will be able to understand need of soft computing techniques CO2: Students will be able to apply knowledge of different soft computing methods for solving engineering problems CO3: Students will be able to apply combined soft-computing techniques						
Topics Covered	Introduction to expert systems – Definition, Need for expert systems,						6

	Methods of developing expert system – offline training/learning AND on-line training/learning Tools for developing expert systems – Hard Computing vs. Soft Computing, Fuzzy Set Theory, Fuzzy Logic Controllers (FLC). Neural Network (NN) Controllers – back propagation network, SOM, radial basis function networks, recurrent neural networks etc. Learning/optimisation tools – traditional (direct search and gradient based) and non-traditional (genetic algorithms (GAs), simulated annealing etc.) techniques. Combined techniques of soft computing – GA-FLC, GA-NN, NN-FLC, GA-FLC-NN Some Applications MatLab toolbox on GA, FLC and NN.	8 8 10 6 2
Text Books, and/or reference material	**Text Books:** 1. S.S. Rao, Engineering Optimization, Theory and Practics, 3rd Enlarged Edition, New Age International Publishers, New Delhi, 2010. 2. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley, Reading, Mass, 1989. 3. Simon Haykin, Neural Network and Learning Machines, 3rd Edition, Person Education, India 4. D. K. Pratihar, Soft Computing, Narosa Publishers, 2011 5. Timothy J. Ross, Fuzzy Logic with Engineering Applications, 3rdEdition, Wiley, 2011.	
	Reference Books: 1. Soft Computing and Its Applications, Vol. 1 & 2, Kumar S. Ray, Apple Academic Press	

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9022	Modern Manufacturing process	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Advanced Mechanics of Solids		CT+EA					
Course Outcomes							
Topics Covered	ECM: Working Principle; ECM Machine Tool; Process performances; Advantages, limitations and applications; ECG- Working Principles; ECG Machine Tool; Process performances; Advantages, limitations and applications; Electrochemical Deburring (ECDe), Shaped Tube Electrolytic Machining (STEM).						8 6

	EDM: Working Principles, EDM Machine Tool – Power Supply, Dielectric System, Electrodes, Servo-system, Pulse generating Circuits and analysis, Process Variables and Process Characteristics; Electrical Discharge Grinding	2 2
	Wire-cut EDM: Working Principles, EDM Machine Tool, Process Variables and Process Characteristics	6
	USM: Working Principles, USM Machine Tool, Mechanics of cutting, Process capabilities, Advantages, limitations and applications.	2 4
	LBM: Production of LASERs, Working Principles of LBM, Types of LASERs, Process characteristics, Advantages, Limitations and Applications.	3
	EBM: Production of Electron Beam, Working Principles of EBM, Focusing and control of electron beam, Process characteristics, Advantages, Limitations and Applications	4
	AJM, Water Jet Machining and Abrasive Water Jet Machining	2
	Chemical Machining	5
	Microfabrication and Micromachining	4
	Rapid Prototyping	
Text Books, and/or reference material	**Text Books:** 1. Nonconventional Machining Process, V.K.Jain 2. Modern Machining Process, Pandey and Shaw	
	Reference Books: 1. Manufacturing Science, Ghosh and Mallik 2. Nonconventional Machining Process, P.K.Misra	

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9023	**Computer Aided Design**	PEL	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Machine Design		CT+EA					
Course Outcomes	CO1: Able to understand scope and application of CAD/CAE tools in industry CO2: Able to learn geometric modeling and computer graphics concept in CAD tools. CO3: Students will be able to analyze mechanisms by computer aided tools CO4: Able to understand the different design analysis and optimization tools in CAD.						
Topics Covered	Introduction: Current trends in Design & Manufacturing, Fundamental concept of CAD-CAM-CAE, Product Life-cycle. (2) Computer Graphics: Fundamentals of Geometric transformations, Viewing transformations, Projections, Clipping, & Hidden line/surface removal, Graphics standards, CAD-CAM Data Exchange. (8) Geometric Modeling: Types and mathematical representation of Wire-frame entities, Surface entities, Solid modeling and concepts of B-rep and CSG representation schemes.						

	(10) Engineering Analysis Tools: Computer aided analysis of multi-body systems, Role of Finite Element Modeling (FEM) in design. (6) Design Optimization: Problem formulation, unconstrained and constrained optimization problems, Non-linear programming methods. (10) Virtual Prototyping: Introduction to Virtual Prototyping & Virtual Reality Tools and its applications in Mechanical Engineering. (4)
Text Books, and/or reference material	**Text Books:** 1. Mastering CAD/CAM, I.Zeid 2. Geometric Modelling, M.Mortenson
	Reference Books: 1. Mathematical Elements for Computer Graphics, Roger, Adams 2. Engineering Optimization, Theory and Practices, S. S. Rao

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9024	**Mechanics of Composite and Functionally Graded Materials**	PEL	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Advanced Mechanics of Solids		CT+EA					
Course Outcomes	CO1: Students will learn why and how different materials are combined to get a new material with better properties and what will be the properties of new materials. CO2: Students will be able to analyze composite structures like beam plates. CO3: Students will learn about the mechanics FGM.						
Topics Covered	Composites, various reinforcement and matrix materials (2) Manufacturing of composites materials (3) Concept of orthotropic, transversely isotropic material, stress-strain relation for orthotropic and transversely isotropic material. Engineering constants for these materials, Transformation of stress and strain. (8) Micromechanical behavior of lamina (6) Macro mechanical behavior of lamina, Classical lamination theory, Laminate stiffness of a few cases, Stress strain variation in a laminate (8) Equation of equilibrium for laminated plates for bending, Solution technique for bending of simply supported laminated plates under uniformly distribute transverse load. (7) Failure criterion of composites (3) Introduction to FGM (3)						
Text Books, and/or reference material	**Text Books:** 1. Mechanics of Composite Materials, R. M. Jones 2. Fiber-Reinforced Composites: Materials, Manufacturing, and Design, P. K. Mallick 3. The behaviour of Structures Composed of Composite Materials By J. R. Vinson and L. Sierakowski						

	Reference Books: 1. Mechanics of Laminated Composite Plates and Shells Theory and Analysis, J. N. Reddy 2. Engineering Mechanics of Composite Materials, Daniel

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9025	**Modeling and Simulation of Mechanical Systems**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
ME 1001		CT+EA					
Course Outcomes	CO1: Students will be able to identify the importance of modelling and simulation of Engineering systems CO2: Students will be able to model and simulate behavior of any engineering system. CO3: Students will be able to interrelate between systems in different energy domains.						
Topics Covered	Elements of analytical mechanics; classification of constrains, Principles of virtual work, Lagrange's first equation. Lagrange's second equation. Hamilton's equations. (6) Nonholonomic mechanical system dynamics, Routh and Gibb's equation, Kane dynamics with application to multi body systems. (6) Modelling of systems involving continuous medium. Hamilton's principle for continuous medium. Elements of thermo-continuum and theory of constitutive relations. (8) Modelling and Simulation of Physical System: System models, Dynamic responses of the system, System transfer functions. (6) Fundamental topics in bond graph modeling of physical systems: Elements of multi-bond graphs, Thermo-mechanical bond graphs and continuous systems and other systems of typical interest. Introduction to various system simulation software. (14)						
Text Books, and/or reference material	**Text Books:** 1. Advanced Dynamics of Mechanical Systems, F.Cheli, G.Diana 2. Bondgraph in Modeling, Simulation& Fault Identification, Mukherjee, Karmakar, Samantaray						
	Reference Books 1. System Dynamics, D. C. Karnopp, D. L. Margolis, R. C. Rosenberg 2. Modeling and Simulation of Dynamic Systems, R.L.Woods, K.L.Lawrence						

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9026	**Tribology**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Mechanics,		CT+EA					

Solid Mechanics, Fluid Mechanics	
Course Outcomes	CO1: To learn the basic knowledge of surface topography and contact between engineering surfaces. CO2: To learn the basic theory and application of friction and wear for different materials CO3: To learn about lubricants and lubrication for different bearings CO4: Introduced to Biotribology of human joints CO5: Introduced to Microtribology for MEMS applications
Topics Covered	Surface topography: Measurement of surface topography; Quantifying surface roughness; The topography of engineering surfaces. (3) Contact between surfaces: Hertzian contact – sphere on sphere contact and cylinder on cylinder contact; Contact between rough surfaces. (5) Friction and Wear of contact surfaces: Laws and Theories of friction and wear; Friction and Wear of different materials; Application to friction materials. (10) Lubricants and lubrication: Viscosity of lubricants; Composition and properties of oils and greases; Reynolds equation; Type of lubrications - Hydrostatic lubrication, Hydrodynamic lubrication; Elasto-hydrodynamic lubrication; Boundary lubrication, and application to bearings. (20) Micro-tribology: Surface forces and adhesion; Atomic force microscopy (AFM); Friction, wear and lubrication on atomic level; Applications to MEMS. (8) Bio-tribology: Natural human joints; Structure and properties of articular cartilage; Mechanism of synovial lubrication: Mechanism of articular cartilage damage; Artificial joint replacements; Skin Tribology (10)
Text Books, and/or reference material	**Text Books:** 1) Engineering Tribology - Dr. Prasanta Sahoo 2) Introduction to Tribology of Bearings -- B.C.Majumder 3) Principles of Tribology-- J.Halling 4) Basic Lubrication Theory - Alastair Cameron

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9028	**Material Handling Equipment**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
ME1001		CT+EA					
Course Outcomes	CO1: Students will be able to identify the importance of use of mechanical handling machineries. CO2: Students will be able to design different types of conveyors and cranes.						
Topics Covered	Classification of materials and equipment. 2 Conveying equipment: Belt conveyor, Construction and layouts, Belt selection and power calculation. 8 General features and calculations of capacity and power of bucket elevator. 2 Apron, Scraper and screw conveyors; Roller conveyor, Chain-trolley conveyor, pneumatic conveying. 6 Principles of working of vibratory conveyor, high angle conveyor, pipe conveyor, long						

	distance conveyor. 4 Duties of lifting equipment, Selection of rope, chain, sheaves and drums. 4 Hand operated equipment, Electric hoists. 4 Electric overhead traveling cranes; construction and calculations of power for lifting and traveling, Crane motors and brakes, Grab operations. 10
Text Books, and/or reference material	**Text Books:** 1. Materials Handling Equipments-- Rudenko N. 2. Materials Handling-- Oberman Y
	Reference books: 1. Belt Conveyors for Bulk Materials—CEMA 2. Crane Design (Theory and Calculations of Reliability-- Hogan J.

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9029	Optimization in Engineering Design	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
		CT+EA					
Course Outcomes	CO1: Students will be able to describe and formulate optimization problems CO2: Students will be able to apply knowledge of different optimization methods for solving engineering problems CO3: Students will be able to differentiate between optimization methods and suggest a suitable technique applicable for a specific problem.						
Topics Covered	*Introduction to optimization problem, problem formulation and setup* Introduction: Engineering Application Statement and Classification of the Optimization Problem Optimization Techniques Classical Methods: Single Variable Optimization; Multivariable Optimization without any Constraints with Equality and Inequality Constraints, Kuhn–Tucker Conditions Linear Optimization Methods *Nonlinear Optimization Methods* One-Dimensional Minimization Method Unimodal Function Elimination Method – Dichotomous Search, Fibonocci and Golden Method Interpolation Method – Quadratic and Cubic Interpolation Method Unconstrained Minimization Method -- Univariate, Conjugate Directions, Steepest Descent (Cauchy) Method, Newton's Method, Marquardt Method, Quasi-Newton Method Direct Methods - Random Search Methods, Sequential Linear Programming, Sequential Quadratic Programming Indirect Methods - Basic Approach of the Penalty Function Method, Interior						

	Penalty Function Method, Exterior Penalty Function Method ***Heuristic Techniques*** Genetic Algorithms Simulated annealing *Practical Aspects of Optimization* Reduction of size of an optimization problem Scaling of design variables and constraints Introduction to optimization Toolbox in MATLAB
Text Books, and/or reference material	**Text Books:** 1. Engineering Optimization, Theory and Practices, S. S. Rao 2. Optimization Concepts and Applications in Engineering, Belegundu and Chandrupatla
	Reference books: 1. Numerical Optimization Techniques for Engineering Design with Applications, Vanderplaats 2. Optimization Methods for Engineering Design, R. L. Fox 3. Genetic Algorithms in Search, Optimization and Machine Learning, David E. Goldberg.

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Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ME 9030	**Design of Machine Tools**	**PEL**	**3**	**1**	**0**	**4**	**4**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
Nil		CT+EA					
Course Outcomes							
Topics Covered		Machine Tools Drives: Layout and Design of Speed and Feed Gear boxes, Stepless speed variation. Machine tool guides beds and columns Hydrostatic and hydrodynamic lubrication Design of lead screws, recirculating ball-screws Design of machine tool spindles Static and dynamic stiffness of machine tool structures. Vibration of machine tools, Chatter and stick slip vibrations. Control of machine tools: Hydraulic and Electrical controls, Numerical control. Static and dynamic acceptance tests, Built in inspection units					
Text Books, and/or reference material		**Text Books:** 1. Principle of Machine Tools, Sen and Bhattacharya 2. Computer Control of Manufacturing Systems, Koren Y.					
		Reference books: 1. Machine Tool Engineering, N.K.Mehta 2. Numerical Control & Computer Aided Manufacturing, Kundra, Rao, Tiwari.					

PROGRAM OUTCOMES

PO1: Technical knowledge: Project work improves the knowledge of students about Machine Design as the allotted topics are based on the Machine Design field.

PO2: Technical report writing: For executing the project work and compilation of the data, the presentation of results a technical report writing skill is required. Therefore, project work develops the technical report writing skill in the students.

PO3: Demonstrate a degree of mastery: The execution of project work and compilation of the data, a planning is required. Therefore, project work develops the planning ability in students. Students analyze, evaluate and apply the collected information /data systematically and on that basis make defensible decisions.

PO4: Professional ethics and responsibilities: While writing project report, students are instructed to follow ethical practice by directing them to avoid plagiarism and citing the works of other researchers properly in the text.

PO5: Life-long learning: Execution of the project work develops the ability in the students to continuously update their knowledge through internet portals, journals, text books, reference books. They come to know via internet that information has been continuously modified and not remain limited to text books, and therefore, updating the knowledge on the regular basis is essential.

MAPPING BETWEEN COURSES AND POs

Course Code	Course Title	Connected POs
ME 1001	Machine Dynamics and Control	PO1, PO2, PO3
ME 1002	Advanced Mechanics of Solids	PO1, PO2, PO3, PO4
ME 1003	Kinematic Analysis and Synthesis of Mechanisms	PO1, PO2, PO3, PO4
ME 1051	Dynamics Laboratory	PO1, PO2, PO3, PO4, PO5
ME 1052	Applied Computational Methods Lab	PO1, PO2, PO3, PO4, PO5

ME 2001	Advanced Machine Design	PO1, PO2, PO3, PO5
ME 2002	Advanced Mechanical Vibrations	PO1, PO3, PO5
ME 2003	Theory of Elasticity and Plasticity	PO1, PO3, PO5
ME 2051	Computer Aided Design Laboratory	PO1, PO2, PO3, PO4, PO5
ME 2052	Seminar –I (Non Project)	PO1, PO2, PO3, PO4, PO5
ME 2053	Project-I	PO1, PO2, PO3, PO4, PO5
ME 3051	Project-II	PO1, PO2, PO3, PO4, PO5
ME 3052	Project Seminar-I	PO1, PO2, PO3, PO4, PO5
ME 4051	Project-III	PO1, PO2, PO3, PO4, PO5
ME 4052	Project Seminar-II and Viva-Voce	PO1, PO2, PO3, PO4, PO5

MAPPING BETWEEN COs AND POs

Points are given in terms no (**N**), low (**L**), medium (**M**) and high (**H**) correlation.

Course Code	**Course Title**	**COs**	**POs**				
			PO1	**PO2**	**PO3**	**PO4**	**PO5**
ME 1001	Machine Dynamics and Control	CO1	H	M	H	N	H
		CO2	H	N	M	N	N
		CO3	H	N	M	N	L
		CO4	H	H	H	N	H
		CO5	H	N	H	N	H
ME 1002	Advanced Mechanics of Solids	CO1	H	N	H	N	M
		CO2	H	M	H	N	M
		CO3	H	M	H	N	H
ME 1003	Kinematic Analysis and Synthesis of Mechanisms	CO1	H	M	H	N	N
		CO2	H	M	H	N	H
		CO3	H	M	H	N	N
ME 1051	Dynamics Laboratory	CO1	H	H	H	M	N

		CO2	H	H	H	M	M
ME 1052	Applied Computational Methods Lab	CO1	H	H	H	M	N
		CO2	H	H	H	N	N
		CO3	H	H	H	N	N
ME 2001	Advanced Machine Design	CO1	H	N	H	N	N
		CO2	H	N	M	N	L
		CO3	H	N	H	N	N
		CO4	H	H	H	N	H
		CO5	H	N	H	N	M
ME 2002	Advanced Mechanical Vibrations	CO1	H	N	L	N	N
		CO2	H	N	H	N	L
		CO3	H	N	M	N	L
		CO4	H	N	M	N	M
ME 2003	Theory of Elasticity and Plasticity	CO1	H	N	M	N	N
		CO2	H	N	M	N	L
ME 2051	Computer Aided Design Laboratory	CO1	H	H	H	N	M
		CO2	H	H	H	N	M
		CO3	H	N	M	N	N
ME 2052	Seminar –I (Non Project)	CO1	H	N	H	H	H
		CO2	H	H	H	L	N
		CO3	L	H	L	M	N
		CO4	L	H	L	H	M
ME 2053	Project-I	CO1	H	H	H	H	H
		CO2	H	M	H	L	N
		CO3	H	H	H	H	H
ME 3051	Project-II	CO1	H	H	H	H	H
		CO2	H	M	H	L	N
		CO3	H	H	H	H	H
ME 3052	Project Seminar-I	CO1	H	N	H	H	H
		CO2	H	H	H	L	N

		CO3	L	H	L	M	N
		CO4	L	H	L	H	M
ME 4051	Project-III	CO1	H	H	H	H	H
		CO2	H	M	H	L	N
		CO3	H	H	H	H	H
ME 4052	Project Seminar-II and Viva-Voce	CO1	H	N	H	N	H
		CO2	H	H	H	N	H
		CO3	H	M	H	M	M
		CO4	H	H	H	M	H

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