Annasaheb Dange College of Engineering and Technology, Ashta

(An Empowered Autonomous Institute)

Curriculum Structure

F.Y. M.Tech. - Mechanical Engineering Design

SEM I – II

w.e.f. 2025-26

Department of Mechanical Engineering

Established: 1999

Annasaheb Dange College of Engineering and Technology

Ashta - 416301, Dist. : Sangli, Maharashtra

(An Empowered Autonomous Institute)

F.Y. M. Tech. – Mechanical Engineering Design
[Level 6.5, PG Diploma] Semester - I

Sr. No.	Course Category	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Marks)				
										Theory			Laboratory	
										MSE	TA	ESE	CIA	ESE
01	MC	LIT1	0DEMC501	Computational Methods and Optimization	3	-	4	-	5	40	20	40	50	50
02	PC	LIT2	0DEPC502	Advanced Design Engineering	3	-	4	-	5	40	20	40	50	-
03	RM	T1	0DERM503	Research Methodology	3	1	-	-	4	40	20	40	-	-
04	PE	T1	0DEPE5**	Program Elective - I	3	1	-	-	4	40	20	40	-	-
05	PE	T1	0DEPE5**	Program Elective - II	3	1	-	-	4	40	20	40	-	-
06	MA	T2	0CEMA514	Research Paper Writing	2	0	0	-	0	-	50	-	-	-
				Total	**17**	**3**	**8**	**-**	**22**					

Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits, MSE - Mid-Semester Examination. CIA-Continuous Internal Assessment, TA - Teachers Assessment, ESE-End-Semester Examination

Minimum Passing Criteria	TA (Theory) : ≥ 8 / 20	MSE + ESE (Theory) : ≥ 32 / 80	TA (Theory) / CIE (Lab) : ≥ 20 / 50	ESE (Lab) : ≥ 20/50

Program Elective- I		**Program Elective- II**	
0DEPE504	Solid Mechanics	0DEPE509	Design for Manufacturing and Assembly
0DEPE505	Analysis and Synthesis of Mechanisms	0DEPE510	Experimental Stress Analysis
0DEPE506	Mechanics of Composite Materials	0DEPE511	Reliability Engineering
0DEPE507	Tribology	0DEPE512	Product Design and Development
0DEPE508	Process Equipment Design	0DEPE513	Reverse Engineering

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F.Y. M. Tech. – Mechanical Engineering Design
[Level 6.5, PG Diploma] Semester - II

Sr. No.	Course Category	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Marks)				
										Theory			Laboratory	
										MSE	TA	ESE	CIA	ESE
01	PC	LIT1	0DEPC515	Advanced Finite Element Analysis	3	-	4	-	5	40	20	40	50	50
02	PC	LIT2	0DEPC516	Advanced Vibration and Acoustics	3	-	2	-	4	40	20	40	50	-
03	PE	T1	0DEPE5**	Program Elective - III	3	1	-	-	4	40	20	40	-	-
04	PE	T1	0DEPE5**	Program Elective - IV	3	1	-	-	4	40	20	40	-	-
05	OE	T1	0DEOE5**	Open Elective	3	-	-	-	3	40	20	40	-	-
06	MA	T2	0DEMA530	Pedagogy Studies	2	-	-	-	-	-	50	-	-	-
07	VS	L2	0DEVS531	Seminar	-	-	4	-	2	-	-	-	50	-
				Total	**17**	**2**	**10**	**-**	**22**					

Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits, MSE - Mid-Semester Examination. CIA-Continuous Internal Assessment, TA - Teachers Assessment, ESE-End-Semester Examination

Minimum Passing Criteria	TA (Theory) : ≥ 8 / 20	MSE + ESE (Theory) : ≥ 32 / 80	TA (Theory) / CIE (Lab) : ≥ 20 / 50	ESE (Lab) : ≥ 20/50

Program Elective- III		**Program Elective- IV**		**Open Elective**	
0DEPE517	Fracture Mechanics	0DEPE522	Machining Dynamics	0DEOE527	Optimization Techniques
0DEPE518	Vehicle Dynamics	0DEPE523	Automatic Control	0DEOE528	Operation Research
0DEPE519	Robotics	0DEPE524	Computational Fluid Dynamics	0DEOE529	Composite Materials
0DEPE520	Condition Monitoring and Fault Diagnosis	0DEPE525	Design for Sustainability		
0DEPE521	Machine Tool Design	0DEPE526	Material Handling Equipment Design		

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S.Y. M. Tech. – Mechanical Engineering Design
[Level 6.5, PG Diploma] Semester - III

Sr. No.	Course Category	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Marks)				
										Theory			Laboratory	
										MSE	TA	ESE	CIA	ESE
01	SL	T2	0DESC532	Self-Learning Course I	4	-	-	-	4	-	50	-	-	-
02	MA	T2	0DEMA533	Internship	-	-	-	-	-	-	50	-	-	-
03	VS	L1	0DEVS534	Dissertation Phase I	-	-	24	-	12	-	-	-	100	100
				Total	**4**	**-**	**24**	**-**	**16**					

Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits, MSE - Mid-Semester Examination. CIA-Continuous Internal Assessment, TA - Teachers Assessment, ESE-End-Semester Examination

Minimum Passing Criteria	TA (Theory) : ≥ 8 / 20	MSE + ESE (Theory) : ≥ 32 / 80	TA (Theory) / CIE (Lab) : ≥ 20 / 50	ESE (Lab) : ≥ 40/100

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S.Y. M. Tech. – Mechanical Engineering Design
[Level 6.5, PG Diploma] Semester - IV

Sr. No.	Course Category	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme (Marks)				
										Theory			Laboratory	
										MSE	TA	ESE	CIA	ESE
01	SL	T2	0DESC535	Self-Learning Course II	4	-	-	-	4	-	50	-	-	-
02	VS	L1	0DEVS536	Dissertation Phase II	-	-	32	-	16	-	-	-	100	100
				Total	**4**	**-**	**32**	**-**	**20**					

Legends: L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits, MSE - Mid-Semester Examination. CIA-Continuous Internal Assessment, TA - Teachers Assessment, ESE-End-Semester Examination

Minimum Passing Criteria	TA (Theory) : ≥ 8 / 20	MSE + ESE (Theory) : ≥ 32 / 80	TA (Theory) / CIE (Lab) : ≥ 20 / 50	ESE (Lab) : ≥ 40/100

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Established: 1999

Annasaheb Dange College of Engineering and Technology

Ashta - 416301, Dist. : Sangli, Maharashtra

(An Empowered Autonomous Institute)

Department : Mechanical Engineering

Programme : M.Tech. – Mechanical Engineering Design

Curriculum Revision : Revision: R0, with effect from the AY 2025 – 26 to the students of PG Programme.

Course Category	Acronym	I	II	III	IV	Total	% Of Category
Program Specific Mathematical Course (PSMC)	MC	5	0	0	0	5	6.25
Research Methodology	RM	4	0	0	0	4	5
Program Core	PC	5	9	0	0	14	17.5
Program Elective	PE	8	8	0	0	16	20
Open Elective	OE	0	3	0	0	3	3.75
Vocational and Skill Enhancement Course (VSEC)	VS	0	2	12	16	30	37.5
Self-Learning Course (SLC)	SL	0	0	4	4	8	10
	Total	**22**	**22**	**16**	**20**	**80**	**100**

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Department of Mechanical Engineering
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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**MC**
Course Code, Course Title	0DEMC501, Computational Methods and Optimization					**Type**	**LIT1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	-	4	-		5	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		50	50

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Apply appropriate numerical methods to solve nonlinear equations and implement them using MATLAB.
CO2	Solve systems of linear equations using direct and iterative numerical techniques and validate solutions through MATLAB programming.
CO3	Analyze and interpret standard probability distributions and sampling theorems for modeling and solving real-world engineering problems.
CO4	Compute eigenvalues and eigenvectors and solve ordinary and partial differential equations using numerical algorithms, supported by MATLAB implementation.
CO5	Formulate and evaluate optimization problems using single-variable and multivariable numerical optimization methods for engineering applications.

Syllabus:

Module	Contents	Lecture Hours
I	**Roots of Equations :** Solving Quadratic Equations Exactly, Solving Cubic Equations Exactly, Bisection Method, False-Position Method, Newton-Raphson Method, Secant Method.	7
II	**Simultaneous Linear Equations:** Introduction to system of linear algebraic equations, Cramer's rule, Gaussian Elimination, Gauss-Jordan Method, LU Decomposition, Gauss-Jacobi and Seidel Method, Cholesky Method.	8
III	**Probability distributions and theorems:** Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like x^2, t, F.	7
IV	**Eigen values and Eigen Vectors:** Bounds on Eigen Values, Jacobi method for symmetric matrices, Given's method for symmetric matrices, Householder's method for symmetric matrices, Rutishauser method for arbitrary matrices, Power method.	7
V	**Ordinary and Partial Differential Equations:** Primer on Ordinary Differential Equations, Initial Value Problems, Euler's Methods, Runge-Kutta methods, Predictor - Corrector Method, Boundary Value Problems. Introduction to Partial Differential Equations, Parabolic Partial Differential Equations, Elliptic Partial Differential Equations	9
VI	**Optimization:** Golden Section Search Method, Newton's Method, Multidimensional Direct Search Method, Multidimensional Gradient Method, Simplex Method	7
	Total Lecture Hours	45

List of Experiments with CO Mapping

S. No.	Title / Topic of the Experiment	CO Mapped
1	MATLAB program on Bisection method	1
2	MATLAB program on False Position method	1

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3	MATLAB program on Newton Raphson method	1
4	MATLAB program on Secant method	1
5	MATLAB program on Gauss Elimination method solve the system of linear equations	2
6	MATLAB program on Gauss Jordon method solve the system of linear equations	2
7	MATLAB program on Gauss Jacobi method solve the system of linear equations	4
8	MATLAB program on Runge Kutta Method to solve ordinary differential equations.	4
9	MATLAB program on Euler's Method to solve ordinary differential equations.	4
10	MATLAB program on Predictor - Corrector Method to solve ordinary differential equations	4
Total Practical Sessions	**30**	**Total Practical Hours** **60**

Text Books:

1. B.S. Grewal , *Numerical Methods in Engineering & Science* , 11th Edition Khanna Publication ,2013
2. Ronald E, Walpole, Sharon L. Myers, Keying Ye, *Probability and Statistics for Engineers And Scientists*,8th Edition,2007
3. J. B. Doshi, *Differential Equations for Scientists and Engineers*, , 10th Edition, Narosa, New Delhi 2017
4. E. Isaacson, H. B. Keller, *Analysis of Numerical Methods*, 4th Edition, Dover Publications, 1994

References:

1. Douglas C. Montgomery, *Design and Analysis of Experiments*,1st Edition, Wiley,2009
2. S. P. Gupta, *Statistical Methods*,37th Edition, S. Chand & Sons, 2008
3. William W. Hines, Douglas C, Montgomery, David M. Goldsman, *Probability and Statistics for Engineering*,4th Edition, Willey, 2006
4. S.C. Chapra, R.P. Canale, *Numerical Methods for Engineers*,7th Edition,2013

Online Learning Resources:

1. NPTEL Course on Numerical Methods by Dr. MANSOOR P., MES College of Engineering, Kuttippuram
   Link: https://onlinecourses.swayam2.ac.in/cec25_ma24/preview
2. Online course on Numerical Methods for Engineers by Jefaarey R Chasnov, The Hongkong University of Science & Technology.
   Link: https://www.coursera.org/learn/numerical-methods-engineers

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Department of Mechanical Engineering
Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PC**
Course Code, Course Title	**0DEPC502, Advanced Design Engineering**					**Type**	**LIT2**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	-	4	-	5		
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		50	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Apply statistical methods such as ANOVA, regression, reliability, hazard and fault tree analysis to solve engineering problems and ensure safe and reliable designs.
CO2	Analyse fatigue and creep behaviour of materials under cyclic and high-temperature loading, considering influencing factors, creep laws, and stress relaxation effects.
CO3	Use optimization techniques including linear, geometric, simplex, structural and shape optimization to develop efficient and effective engineering solutions.
CO4	Design mechanical components by applying fatigue and brittle failure criteria, accounting for thermal stresses, safety, reliability, and manufacturability aspects.
CO5	Develop 2D/3D models and assemblies using advanced CAD/CAE tools, applying transformations, feature modelling, and assembly techniques in Pro/E or CATIA.

Syllabus:

Module	Contents	Lecture Hours
I	**Engineering statistics:** Analysis of variance (ANOVA), factorial design and regression analysis, Reliability theory, design for reliability, Hazard analysis and fault tree analysis.	7
II	**Fatigue and Creep:** Introduction, Fatigue strength, factors affecting fatigue behavior, Influence of super imposed static stress, Cumulative fatigue damage, Fatigue under complex stresses, Fatigue strength after over stresses, True stress and true strength, mechanism of creep of material at high temperature, Exponential creep law, Hyperbolic sine creep law, Stress relaxation, bending etc.	8
III	**Optimization:** Introduction, multivariable search methods, linear & geometric programming, structural and shape optimization and simplex method.	8
IV	**Design for Materials and Processes:** Brittle failure criteria for design, Fatigue failure criteria for design, Design for different machining process, Design for assembly maintenance & safety.	7
V	**Design for Thermal Stresses:** Theory of elasticity approach, thermal stresses in cylindrical parts with and without holes. Thermal stress due to form constraint and contiguity constraint, combined effect of pressure and thermal stresses, methods of heat removal, methods to reduce thermal stresses.	7
VI	**Design of mechanical components:** **a) Gear Design: -** Involute gears, tooth thickness, interference, undercutting, rack shift etc. Profile modification of spur, helical gears etc. **b) Spring Design** - Vibration and surging of helical springs, helical springs for maximum space efficiency, analysis of Belleville springs, ring spring, volute spring & rubber springs. Design for spring suspension. **c) Design of Cam shaft** with valve opening mechanism, piston, cylinder, connecting rod etc.	8
	Total Lecture Hours	45

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List of Experiments with CO Mapping			
S. No.	**Title / Topic of the Experiment**		**CO Mapped**
1	Develop Programs for Transformations in CAD		4
2	Develop programs for Synthetic Curves in CAD		4
3	Introduction to Pro/E and working with features like Extrude & Revolve in sketch model		4
4	Model solids with features like Hole, Round, Chamfer and Rib		4
5	Model solids with features like Pattern, Copy, Rotate, Move and Mirror		4
6	Advanced modelling tools (Sweep, Blend, Variable section Sweep etc.)		4
7	Assembly modelling in Pro/E/CATIA, Generating, editing, and modifying drawings in Pro/E/CATIA		4
Total Practical Sessions	**30**	**Total Practical Hours**	**60**

Text Books:

1. M.F. Spotts, *Design of Machine Elements*,8th Edition, Pearson,2012
2. Robert Norten, *Machine Design*, 8th Edition, Pearson,2010
3. D.W.Dudley, *Practical Gear Design*, 8th Edition, CRC Press,2004

References:

1. G.E. Dieter, *Mechanical Metallurgy*,5th Edition, Tata McGraw-Hill, New Delhi,2011
2. G.E. Dieter, *Engineering Design: A Materials and Processing Approach*,3rd Edition, Tata McGraw-Hill, New Delhi,2008
3. V Ramamurti, *Computer Aided Mechanical Design and Analysis*, 3rd Edition,Tata McGraw-Hill, New Delhi,2011

Online Learning Resources:

1. NPTEL course on CAD/CAM Computer Aided Design / Computer Aided Manufacturing by Dr. K.Tamil Mannan, Indira Gandhi National Open University, New Delhi
   Link: https://onlinecourses.swayam2.ac.in/nou25_me10/preview

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**RM**
Course Code, Course Title	**0DERM503, Research Methodology**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	1	-	-	4		

Examination Scheme (Marks)	**Theory**				**Practical**		**CIA**	**ESE**
	MSE	**TA**	**ESE**					
	40	20	40				-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the objectives, importance, and types of research, and define a research problem, ensuring that key concepts are correctly included.
CO2	Develop a research framework by reviewing relevant literature and constructing a conceptual or theoretical framework, given a set of research papers, ensuring the literature review
CO3	Apply. the research design and sampling technique for formulating methodology of a given research problem aligned with research objectives
CO4	Utilize appropriate data collection methods by identifying and implementing suitable techniques, adherence to ethical guidelines
CO5	Analyze and interpret research data by using statistical tools to process information and draw conclusions, given a dataset, ensuring accuracy in interpretation and adherence to academic writing standards

Syllabus:

Module	**Contents**	**Lecture Hours**
I	**Introduction:** Introduction to Research and Problem Definition meaning, Objective and importance of research, Types of research, steps involved in research, defining research problem.	**6**
II	**Reviewing the literature:** Place of the literature review in research, bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.	**8**
III	**Research Design:** Need for Research Design, Features of Good Design, Different Research Designs, Basic Principles of Experimental Designs, Sampling Design, Steps in Sampling Design, Types of Sampling Design, Sampling Fundamentals, Estimation, Sample size Determination, Random sampling	**8**
IV	**Data Collection:** Classification of Data, methods of Data Collection, Sampling, Sampling techniques, Procedure and methods, Ethical considerations in research.	**7**
V	**Data Analysis and Interpretation:** Data analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software (e.g. SPSS etc.), Statistical inference, Interpretation of results.	**8**
VI	**Technical Writing and Reporting Of Research:** Types of research report: Dissertation and Thesis, research paper, review article, short communication, conference presentation etc., Referencing and referencing styles, Research Journals, Indexing and citation of Journals, Intellectual property, Plagiarism.	**8**
	Total Lecture Hours	**45**

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References:

1. C.R. Kothari,Gaurav Garg, *Research Methodology Methods and Techniques*,3rd Edition, New Age International,2010
2. Ranjit Kumar, *Research Methodology: A Step by Step Guide for Beginners*, 2nd Edition, SAGE, 2005
3. Donald Cooper & Pamela Schindler, *Business Research Methods*,9th Edition, Tata McGraw-Hill, New Delhi, 2011
4. Creswell, John W., *Research design: Qualitative, quantitative, and mixed Methods approaches*, Sage Publications, 2013

Online Learning Resources:

1. NPTEL course on Research Methodology by Prof. G.S. Bajpai, Vice-Chancellor | National Law University, Delhi
   Link: https://onlinecourses.swayam2.ac.in/cec25_lw04/preview
2. NPTEL course on Research methodology in Education by Prof. Shafali Pandya, University of Mumbai.
   Link: https://onlinecourses.swayam2.ac.in/cec25_ed13/preview

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE504, Solids Mechanics**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Analyze the state of stress and strain under plane stress and plane strain conditions using the theory of elasticity
CO2	Analyze the two-dimensional problems in rectangular and polar coordinates.
CO3	Evaluate torsion-induced stresses in shafts, elliptical bars, and rectangular bars using membrane and hydro dynamical analogies
CO4	Develop analytical and computational skills to solve contact stress problems using Hertzian theory and case studies

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction:** Introduction of Theory of Elasticity. Comparison between theory of elasticity and strength of material approaches, assumptions made in theory of elasticity, components of stress, components strain, Generalized Hook's law, Relation between elastic constants Plane stress and plane strain, Principal stress and principal strain, Mohr's circle, Equations of equilibrium, Boundary conditions, Equations of compatibility, Airy stress function	8
II	**Two dimensional problems in rectangular coordinates:** Two Dimensional problems in rectangular co-ordinates, use of polynomial as Airy's Stress Function, Determination of stresses and displacements in cantilever loaded at the end and loaded by uniformly distributed load,	8
III	**Two dimensional problems in polar coordinates:** Problems in polar Co-ordinates-Equation of equilibrium. Equation of compatibility, strain components in polar coordinates, stress distribution symmetrical about an axis, Stresses in circular plate with or without hole, Bending of curved bar, Rotating disks with constant and variable thickness, disk of uniform strength, semi-infinite plate with hole.	7
IV	**Bending of structural members:** Bending of a cantilever, Stress Function, Shear stress distribution and shear center for circular beam. Solution of Bending Problems by Soap-film Method.	7
V	**Torsion:** Torsion of Straight Bars, Torsion of bars with elliptical square and rectangular cross section, Membrane analogy, Hydro dynamical analogy, Torsion of hollow and thin tubes. Membrane stresses in shell and storage vessels.	7
VI	**Contact stresses:** Contact stresses-Assumptions made in Hertz's theory of contact stresses, Case Studies-Determination of area of contact, pressure distribution and stress in sphere-sphere case, cylinder-cylinder case.	8
	Total Lecture Hours	**45**

Text Books:

1. Boresi, A.P. and Sidebottom, O.M, *Advanced Mechanics of Materials*,3rd Edition, John Wiley,1993
2. S. Timoshenko and J.W. Goodier, *Theory of Elasticity*,3rd Edition, Tata McGraw-Hill, New Delhi2011
3. Popov, E.P, *Engineering Mechanics of Solids*,2nd Edition, Prentice Hall India,1998

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References:

1. Chakrabarty, *Theory of Plasticity*, McGraw-Hill Book Company,1990
2. J.P. Den Hartog, *Advanced Strength of Materials*,3rd Edition, Tata McGraw-Hill, New Delhi,2008
3. Sadhu Singh, *Theory of Elasticity*,3rd Edition, Khanna Publisher,2011
4. Timoshenko.S. and Young D.H, *Elements of Strength Materials* Vol. I and Vol. II, 1st Edition,1990

Online Learning Resources:

1. NPTEL course on Mechanics of Solids by Prof. Arunasis Chakraborty IIT Guwahati
   Link: https://onlinecourses.nptel.ac.in/noc25_ce74/preview
2. NPTEL course on Solid Mechanics by Prof. Ajeet Kumar , IIT Delhi.
   Link: https://onlinecourses.nptel.ac.in/noc25_me123/preview

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Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE505, Analysis and Synthesis of Mechanisms**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain fundamental kinematic concepts by defining and describing kinematic pairs, degrees of freedom, and types of mechanisms, given a mechanical system, ensuring accuracy in classification
CO2	Analyze velocity and acceleration in complex mechanisms by performing velocity and acceleration analysis using the normal acceleration and auxiliary point methods
CO3	Evaluate dynamic forces in planar mechanisms by computing inertia forces and performing kinetostatic analysis using the matrix method, of a given linkage system
CO4	Apply curvature theory to determine motion characteristics in dwell mechanisms by identifying fixed and moving centrodes, inflection circles, and key curvature properties of a given dwell mechanism
CO5	Synthesize planar mechanisms for function and path generation by designing and optimizing four-bar and slider-crank mechanisms using graphical and analytical synthesis techniques as per given motion requirement

Syllabus:

Module	Contents	Lecture Hours
I	**Basic Concepts:** Definitions and assumptions, planar and spatial mechanisms, kinematic pairs, degree of freedom	4
II	**Kinematic Analysis of Complex mechanisms:** Velocity-acceleration analysis of complex mechanisms by the normal acceleration and auxiliary point methods.	7
III	**Dynamic Analysis of Planar mechanisms:** Inertia forces in linkages, kinetostatic Analysis of mechanisms by matrix method. Analysis of elastic mechanisms, beam element, displacement fields for beam element, element mass and stiffness matrices, system matrices, elastic linkage model, equations of motion.	8
IV	**Curvature theory:** Fixed and moving centrodes, inflection circle, Euler- Savy equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell mechanisms	8
V	**Graphical Synthesis of Planar mechanisms:** Type, number and dimensional synthesis, function generation, path generation and rigid body guidance problems, accuracy (precision) points, Chebychev Spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, center point and circle point curves, Bermester points, Synthesis for five accuracy points, Branch and order defects, Synthesis for path generation.	8
VI	**Analysis and Synthesis of mechanisms:** **6 a : Analytical synthesis of Planar mechanisms:** Analytical synthesis of four-bar and slider-crank mechanism, Freudenstein's equation, synthesis for four accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers. Complex numbers method of synthesis, the dyad, center point and circle point circles, ground pivot specifications, three accuracy point synthesis using dyad method, Robert Chebychev theorem, Cognates.	10

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	6 b : Kinematic Analysis of Spatial mechanisms: Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms.	
	Total Lecture Hours	**45**

Text Books:

1. J. E. Shigley and J. J. Uicker, *Theory of Machines and Mechanisms*,2nd Edition, Oxford University Press,2012
2. R.L.Norton, *Kinematics and Dynamics of Machinery*,3rd Edition, Tata McGraw-Hill Education Pvt. Ltd.,2011
3. A. Ghosh and A.K.Mallik, *Theory of Machines and Mechanisms*, 3rd Edition, Affiliated East - West Press,2015

References:

1. S.S.Ratan, *Theory of Machines*,3rd Edition, Tata McGraw-Hill Education Pvt. Ltd.,2012
2. J.S.Rao, R.V. Dukkipati, *Mechanism and Machine Theory*,5th Edition,2012

Online Learning Resources:

1. NPTEL Course on Kinematics of Machines, by Prof. Ashok K. Malik, IIT Kanpur.
   Link: https://nptel.ac.in/courses/112104121
2. MIT Open Course Ware – Mechanical Engineering. Includes lecture notes and problem sets on kinematics, dynamics, and design of machinery.
   Link: https://ocw.mit.edu/search/?d=Mechanical%20Engineering&s=department_course_numbers.sort_coursenum
3. Coursera – Kinematics of Mechanisms and Machines
   Link: coursera.org/learn/kinematics

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Department of Mechanical Engineering
Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester I				**Category**	**PE**
Course Code, Course Title	**0DEPE506, Mechanics of Composite Materials**				**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**	
	3	1	-	-	4	

Examination Scheme (Marks)	**Theory**				**Practical**	**CIA**	**ESE**
	MSE	**TA**	**ESE**				
	40	20	40			-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Differentiate composites with respect to various isotropic materials.
CO2	Understand different processing techniques used to manufacture polymer composites.
CO3	Solve for stresses and strains in the lamina.
CO4	Solve for stresses and strains and analyze the laminate using various failure theories
CO5	Design and analyze laminated structures.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction:** Introduction to Composite Materials; Classification of composites, Fibrous Composites, FRP constituents, Reinforcement types, Types of materials (Isotropic, Orthotropic, Anisotropic; Homogeneous and Non-Homogeneous) and terminology used, manufacturing techniques for the composite materials and applications. **Processing of Polymer Composites:** Processing of polymer composites-Various processing Techniques, Open mold processes, Closed mold processes, Filament winding, Pultrusion	8
II	**Ply Stiffness Analysis:** Generalized Hooke's Law-Elastic constants for anisotropic, Orthotropic and isotropic materials. Specially orthotropic ply, generally orthotropic ply, Transformation of elastic constants	7
III	**Ply Strength Analysis:** Isotropic ply, orthotropic ply, failure criteria, sign of shear stresses, choice of failure criterion typical strength properties	7
IV	**Laminate Stiffness Analysis:** Layered laminate, beam constitutive equation, laminate constitutive equation, equivalent elastic constants, stiffness formulation procedure, laminate configuration types, Symmetric SOPL-isotropic plies, specially orthotropic plies, generally orthotropic plies. Symmetric MOPL-isotropic plies, specially orthotropic plies, generally orthotropic plies.	8
V	**Laminate Strength Analysis:** First-Ply-Failure (FRF) Procedure, FPF: symmetric laminate-membrane load, FPF: symmetric laminate- bending load. Last- Ply-Failure (FRF) Procedure, LPF: complete ply failure-membrane load, partial ply failure-membrane load, complete ply failure-bending load, estimated laminate strength	8
VI	**Thin-Walled Composite Sections:** Assumptions and axes systems, axial force, symmetrical bending, unsymmetrical bending, shear forces	7
	Total Lecture Hours	**45**

Text Books:

1. Datoo M H, *Mechanics of Fibrous Composites*, Springer,1991

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2. B.D. Agarwal and L.J. Broutman, *Analysis and Performance of Fibre Composite*, John Wiley & Sons, Inc.,1997
3. Karl T Herakovich, Mechanics of Fibrous Composites, Wiley,1998

References:

1. RM Christensen, *Mechanics of Composite Materials*,2nd Edition, Krieger Publishing Company,2000
2. J.M. Hodgkinson, *Mechanical Testing of Advanced Fibre Composites*,3rd Edition, Woodhead Publishing Limited,2000

Online Learning Resources:

1. NPTEL Course on Mechanics of Composite Materials and Structures by Prof. Mohammed Rabius Sunny, IIT Kharakpur
   Link; https://onlinecourses.nptel.ac.in/noc25_ae33/preview
2. Online Course on Mechanics of Materials I: Fundamentals of Stress & Strain and Axial Loading , by Dr, Wayne Whiteman, Georgia Institute of Technology,
   Link: https://www.coursera.org/learn/mechanics-1

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE507, Tribology**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the theories of Tribology, friction and wear mechanisms
CO2	Apply principle of hydrodynamic lubrication for design of bearing.
CO3	Analyze the hydrostatic bearing for minimum energy loss.
CO4	Apply Reynolds equation for designing gas and elasto-hydrodynamic lubrication system.
CO5	Select appropriate surface treatment for minimum wear and high corrosion resistance.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction:** Tribology in design, industrial applications of Tribology, economic aspects of Tribology, bearing types and materials, tribological aspects for engine components such as bearings, reciprocating components, valve train. Methods of solution of tribological problems.	7
II	**Friction and Wear:** Friction characteristics of metals and non-metals, Laws of friction, causes of friction, friction Measurement, theories of friction-Adhesion, abrasive, Tomlion's and Hardy theory of molecular attraction. Introduction to wear- types of wear and wear mechanisms, factors affecting on wear, measurement of wear. Theories of wear. methods of controlling wear.	8
III	**Hydrodynamic Lubrication:** Working principle, Mechanism of pressure development in oil film, Reynolds equation for hydrodynamic lubrication, hydrodynamic journal bearing, analysis of hydrodynamic journal bearing, Summerfield number, design consideration in hydrodynamic bearing.	8
IV	**Hydrostatic lubrication:** Principle, advantages, limitations and applications of hydrostatic lubrication, hydrostatic step bearing analysis. Energy loss in hydrostatic bearing. Optimum design of hydrostatic bearing, hydrostatic conical bearing. Rheodynamic lubrication.	7
V	**Elasto hydrodynamic lubrication and Gas lubrication:** Elasto hydrodynamic lubrication between two contacting bodies. Hertz's equation for deformation and pressure. Applications of elasto-hydrodynamic lubrications. Gas lubrication-requirements, merits and demerits of gas lubrication, Reynolds equation for gas lubrication, Air bearings.	8
VI	**Surface Engineering:** Introduction, concept and scope of surface engineering, manufacturing of surface layers. Surface engineering for wear and corrosion resistance diffusion and coating. Properties of coatings. Selection of coating for wear and corrosion resistance.	7
	Total Lecture Hours	**45**

References:

1. Bowden, F.P. and Tabor D., *Friction and Lubrication of Solids*, Oxford University press,1986
2. Ernest Rabinowiez, *Friction and Wear of Materials*, Inderscience Publishers,1995
3. Neale M.J., *Tribology-Hand Book*, Butterworth,1995
4. Fuller D. D., *Theory and practice of lubrication of Engineers*, John Wiley sons,1984

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5.Gross W. A., *Gas Film Lubrication*, Wiley,1980

Online Learning Resources:

1. NPTEL Course on Tribology, by Prof. Harish C. Barshilia, IIT Delhi.
   Link: https://nptel.ac.in/courses/112102030
2. MIT Open Course Ware – Tribology, Instructor: Prof. Nam Suh & Dr. Nannaji Saka, Topics: Surface characterization, nano/macro tribology, wear diagnostics, includes Lecture notes, problem sets, and case studies
   Link: https://ocw.mit.edu/courses/2-800-tribology-fall-2004/
3. MIT Open Course Ware – Tribology, Instructor: Prof. Nam Suh & Dr. Nannaji Saka, Topics: Surface characterization, nano/macro tribology, wear diagnostics, includes Lecture notes, problem sets, and case studies

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE508, Process Equipment Design**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Distinguish the types of equipment used in the process industry and their general procedure of design
CO2	Apply various design codes in process equipment design
CO3	Apply the principles of process equipment design, the mechanical aspects of the design and operation of process equipment, including safety considerations
CO4	Understand the detailed designs of several process equipment's.
CO5	Develop knowledge in planning, manufacture, inspection, erection of process equipment and Process Control.

Syllabus:

Module	Contents	Lecture Hours
I	**Process Design Parameters:** Introduction, types and classification of equipment's used in process industry, General design procedure. Materials of construction and corrosion prevention. Introduction to design codes like IS-2825, ASDE Section eight-DIV-II, TEMA. API-650, BS-1500 and 1515.	6
II	**Design of Cylindrical and Spherical Vessels:** Classification of pressure vessels as per BIS code for unfired pressure vessels, Design parameters for pressure vessels. Design of thin cylindrical and spherical pressure vessels, corrosion allowance. Design of end covers. Design of cylindrical pressure vessels under combined loading. Nozzles and flange connections to pressure vessels, Compensation for holes on the pressure vessel, Fabrication process and weld preparation for vessel, Inspection and testing of pressure vessels	9
III	**Design of Thick pressure vessels:** High pressure vessels, construction features, Stresses in thick-walled shells, Multi-shell construction, shrink fit construction, stresses in shrink fit construction, optimum design Support design for pressure vessels. Design of gaskets used with pressure vessels.	7
IV	**Design of storage tanks:** Storage vessels and tanks, Fixed roof storage tanks, Variable volume tanks-vapour lift type and floating roof type, Accessories of storage tanks, column supported storage tanks, Reaction vessel-heating systems of reaction vessels, Design and construction of jackets.	8
V	**Design of other process equipment's:** Design of evaporators, Heat exchangers , Agitators and filters . Piping in the process plant and its design. pipe fitting, linings and flanged connections.	8
VI	**Safety and Maintenance:** Types of hazards in process plants, safety measures, Maintenance of process equipment's.	7
	Total Lecture Hours	**45**

References:

1. Dr. M.V. Joshi, *Process Equipment Design*, Mc-Millan,1994
2. By Browell and Young, *Process Equipment Design*, John Wiley,1997
3. Max and Timasulaus Kalus, *Plant Design and Economics*, McGraw Hill,2001

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4. Cannel Grady, *Industrial Instrumentation Servicing Hand* Book, McGraw Hill,1995
5. Kellen Heward, *Handbook of Instrumentation and Control*, McGraw Hill.,2012
6. Perry John, *Chemical Engineering Handbook*, McGraw Hill,2002
7. B.C. Bhattacharya, *Chemical Equipment Design*,2006
8. D.N.W. Kentis, *Industrial Pipe Work*, McGraw Hill,1992
9. J.M. Coulson Richardson, Sinnott, *Chemical Engineering*, Vol. VII, Maxwell, McMillan,2009
10. H. Bedna., *Pressure Vessel Design Hand Book*,2013
11. D.R. Coughanowr, *Process System Analysis and Control*, McGraw Hill, New York,2000
12. Harvey, second edition, *Theory and Design of Pressure Vessels*, CBS publishers and distribution,2004

Online Learning Resources:

1. NPTEL course on Principles and Practices of Process Equipment and Plant Design by Prof. Gargi Das, Prof. S. Ray IIT Kharagpur
   Link: https://onlinecourses.nptel.ac.in/noc25_ch89/preview
2. NPTEL course on Equipment Design: Mechanical Aspect, by Prof. Shabina Khanam, IIT Roorkee.
   Link: https://onlinecourses.nptel.ac.in/noc25_ch54/preview

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE509, Design for Manufacturing & Assembly**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Describe fundamental design for manufacturing principles under given manufacturing constraints to identify suitable materials and economical production methods with adherence to industry standards.
CO2	Apply design considerations for machining, casting, and forming using standard process guidelines to develop manufacturable components meeting specified tolerance and surface finish requirements.
CO3	Analyze joining, forging, extrusion, and sheet metal processes based on given design specifications to recommend optimal design modifications ensuring manufacturability, structural integrity, and cost-effectiveness.
CO4	Evaluate assembly processes and DFA methodologies for manual and automated assembly systems to optimize design solutions that enhance efficiency, reduce assembly time, and minimize costs.
CO5	Examine failure mode analysis techniques critically by implementing fault tree and success tree methods to improve system reliability while ensuring redundancy and failure prevention strategies

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction to Design for Manufacturing:** Design philosophy steps in design process, general design rules for manufacturability, basic principles of design for economical production, selection of materials for design developments in material technology, criteria for material selection, material selection interrelationship with process selection charts.	7
II	**Design for Machining, Casting & Forming:** Machining process: overview of various machining processes - general design rules for machining, dimensional tolerance and surface roughness, design guidelines for turning, drilling, milling etc. Metal casting: selection of casting process, general design considerations for casting, casting tolerances, product design rules for sand casting. Design recommendation for metal extrusion, stamping, fine blanked parts, rolled formed section. design for forging: forging processes, suitable materials for forging, design recommendations.	8
III	**Design for Joining, forging & Extrusion & sheet metal work:** Review of various welding processes, factors in design of weldments general design guidelines, design of brazed joints. Forging - design factors for forging - closed dies forging design - parting lines of dies drop forging die design - general design recommendations. Extrusion & sheet metal work: design guidelines for extruded sections - design principles for punching, blanking, bending, deep drawing.	8
IV	**Design of Manual & Automatic Assembly:** Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology. Development of the assemble process, choice of assemble method, social effects of automation, Continuous transfer, intermittent transfer, indexing mechanisms, operator paced free transfer machine.	8

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V	**Design for Reliability and Quality:** Introduction to product reliability concepts and metrics; fundamentals of failure analysis and prediction;FMEA:Procedure, severity/occurrence/detection ratings, risk priority number calculation; Principles of design for quality; Design for reliability; Integration of reliability & quality in concurrent engineering; Case studies & applications in mechanical system with optimum approach	7
VI	**Failure Mode Analysis:** Fault tree & success tree methods, symbols used, tie sets, cut sets. failure mode effectiveness & criticality analysis, reliability of systems, series, parallel and redundancy (active, standby), rout of n systems, mixed, complex system.	7
	Total Lecture Hours	**45**

Text Books:

1. Geoffrey Boothroyd, Peter Dewhurst, *Design for Manufacturability*, 1st Edition, McGraw-Hill, 1989
2. Mikell P. Groover, *Fundamentals of Modern Manufacturing*, 5th Edition, Wiley, 2019
3. Serope Kalpakjian, Steven R. Schmid, *Manufacturing Engineering and Technology*, 7th Edition, Pearson,2014
4. George E. Dieter, *Materials and Processing Approach*, 4th Edition, McGraw-Hill,2008
5. Mikell P. Groover, *Introduction to Manufacturing Processes*, 5th Edition, McGraw-Hill,2010
6. Geoffrey Boothroyd, Peter Dewhurst, *Design for Assembly*, 2nd Edition, McGraw-Hill,2002
7. Elsayed A. Elsayed, Nancy G. Leveson, *Reliability Engineering*, 1st Edition, Wiley, 2009
8. J. E. Shigley, *Mechanical Engineering Design*, , 9th Edition, McGraw-Hill,2019

References:

1. Luis R. Silva, John N. Ziegler, *Funaamentals of Welding*,1st Edition, McGraw-Hill, 2004
2. Michael F. Ashby, *Material Selection in Mechanical Design*,3rd Edition, Butterworth-Heinemann,2005
3. William A. J. Chapman, *Failure Modes and Effect Analysis (FMEA)*,2nd Edition, Wiley,2007
4. S. P. Venkatesh, *Failure Analysis and Prevention*,1st Edition, McGraw-Hill,2003
5. Dr. A. K. Choudhury, P. R. Deshmukh, *Product Design and Manufacturing: A Collaborative Approach*,1st Edition, CRC Press,2018
6. Serope Kalpakjian, Steven R. Schmid, *Manufacturing Processes for Engineering Materials*,5th Edition, Pearson,2010

Online Learning Resources:

1. NPTEL Course on Product Design and Manufacturing, by Prof. P.V.M. Rao, IIT Delhi
   Link: https://nptel.ac.in/courses/112104230
2. NPTEL Course on Manufacturing Processes for Product Design, by Prof. A. Ravi Sankar, IIT Kharagpur
   Link: https://onlinecourses.nptel.ac.in/noc22_me56/preview
3. edX Course on Fundamentals of Manufacturing Processes, by MITx
   Link:https://www.edx.org/learn/manufacturing/massachusetts-institute-of-technology-fundamentals-of-manufacturing- processes
4. YouTube – MIT Mechanical Engineering Channel, MIT
   Link: https://www.youtube.com/user/MITMechE

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE510, Experimental Stress Analysis**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the overall concepts of stress/strain analysis by experimental means
CO2	Differentiate Coating methods for stress analysis.
CO3	Analyze photo elastic technique to stress analysis
CO4	Explain the concept of strain gages and its applications
CO5	Calculate plane waves and spherical waves intensity

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction:** Introduction to Experimental mechanics, advantages scope of Experimental mechanics in design, various experimental methods of stress analysis and their relative merits and demerits	8
II	**Two-Dimensional Photo elasticity:** Arrangement of optical elements in a polar scope , theory of photo elasticity ,Plane & circular polariscope, isoclinics and isochromatics properties , selection and method of calibration. Compensation technique, principle stresses separation technique, calibration methods fringe multiplication, scaling model to prototype, application of photo elasticity for two dimensional models.	7
III	**Three-Dimensional Photo elasticity:** Stress locking in model materials, slicing technique, shear difference method scattered light photo elasticity, dynamic photo elasticity.	7
IV	**Strain Gauges:** Electrical Resistance strain gauges : types, gauge factor , sensitivity applications, materials and bonding of strain gauges, surface preparation moisture proofing etc .types of bonds, testing of gauge installations, strain measuring circuits, commercial strain indicators. Rosette Analysis, strain gauge transducers. cross sensitivity , temperature compensation. Semi –conductor strain gauges.	7
V	**Coating methods for stress analysis:** Coating stresses, birefringent coatings (Photoelastic & Brittle coatings), coating sensitivity, coating materials, analysis of brittle- coating data.	8
VI	**Holography:** Equation for plane waves and spherical waves intensity – coherence – spherical radiator as an object (record process) Hurter – Driffeld curve reconstruction process General case. Holographic set up.	8
	Total Lecture Hours	**45**

Text Books:

1. Dally and Riley, *Experimental Stress Analysis*,3rd Edition, Tata McGraw Hill,1978
2. Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, *Experimental Stress Analysis*, Tata McGraw Hill,2003
3. Sadhu Singh, *Experimental Stress Analysis*,6th Edition, Hanna publisher,1996

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References:

1. M. M. Frocht, *Photo elasticity* Vol. I and Vol. II, John Wiley & Sons,2009
2. Kuske, Albrecht & Robertson, *Photo elastic Stress Analysis*, John Wiley & Sons,2007
3. Dave and Adams, *Motion Measurement and Stress Analysis*, Prentice Hall,2001

Online Learning Resources:

1. NPTEL Course on Experimental Stress Analysis by Prof. K. Ramesh IIT Madras
   Link: https://nptel.ac.in/courses/112106068
2. You Tube Video on Experimental Stress Analysis
   Link: https://www.youtube.com/watch?v=7tBBWK2700Y

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE511, Reliability Engineering**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	1	-	-	4		

Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain basics of reliability, maintainability and availability and differentiate among them.
CO2	Estimate parameters of the distributions using probability plotting paper.
CO3	Evaluate system reliability using various techniques.
CO4	Apply fundamentals to estimate maintainability and availability characteristics.
CO5	Analyze field failure data for reliability analysis.
CO6	Apply the fundamentals of reliability and life testing to estimate reliability of component/ system.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction:** Brief history, concepts, terms and definitions, applications, failures of engineering systems and their causes, reliability and quality, repairable and non-repairable systems, theory of probability and reliability, rules of probability, random variable, discrete and continuous probability distributions, reliability improvement techniques.	7
II	**Basic Reliability Models:** The reliability function, bathtub curve, basic reliability model - exponential, Weibull, log-normal, normal, Poisson etc. distributions, calculation of R(t), F(t), f(t), λ(t), MTTF, timed, mode, σ2 and σ for above distributions, Fitting probability distributions graphically and estimation of distribution parameters.	7
III	**Reliability Evaluation of Systems:** Reliability block diagram- Series configuration, Parallel configuration, Mixed configurations, redundant systems, standby redundant, High level versus low level redundancy, k-out-of-n redundancy, network reduction and decomposition methods, Cut and tie set approach for reliability evaluation.	8
IV	**Design for Reliability and Maintainability:** Reliability specifications and system measurements, reliability allocation, design methods, failure analysis, FDEA, system safety, fault tree and success tree methods, maintainability design process, quantifiable measures of maintainability, repair verses replacement.	7
V	**Maintainability and Availability:** **Maintainability** - Objectives of maintenance, types of maintenance, Concept of maintainability, measures of maintainability, mean time to repair (MTTR), Analysis of downtime, Repair time distributions, Stochastic point processes, reliability centred maintenance (RCM). **Availability** - Availability concepts and definitions, important availability measures, inherent, achieved, and operational availability.	8
VI	**Reliability Testing and Data Analysis:** **Reliability testing** – objectives of life testing, types of reliability test, reliability life testing, Burn-in testing, Acceptance testing, Accelerated life testing, highly accelerated life testing (HALT) and reliability growth testing.	8

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	Data Collection & Analysis - Data collection and empirical methods, Estimation of performance measures for ungrouped compete data, Grouped complete data, Analysis of censored data, Pareto analysis, trend testing, goodness-of-fit tests.	
	Total Lecture Hours	**45**

Text Books:

1. Charles E. Ebling, *An Introduction to Reliability and Maintainability Engineering*, Tata McGraw Hill, New Delhi,2004
2. V. N. A. Naikan, *Reliability Engineering and Life Testing*,1st Edition, PHI Learning Private LTD, Delhi,2014
3. L. S. Srinath, *Reliability Engineering*, East West Press, New Delhi,1991
4. Alessandro Birolini, *Reliability Engineering: Theory and Practice*,1st Edition, Springer,2010
5. Roy Billiton and Ronald Norman Allan, *Reliability Evaluation of Engineering Systems: Concepts and Techniques*,1st Edition,1992
6. Patrick D.T. O'Conner, David Newton, Richard Bromley, *Practical Reliability Engineering*,1st Edition, John Wiley and Sons,2002
7. Joel A. Nachlas, *Reliability Engineering: Probabilistic Models and Maintenance Methods*, Taylor and Francis,2005

References:

1. Guangbin Yang, *Life Cycle Reliability Engineering*, 3rd Edition, John Wiley and Sons,2007
2. W. R. Blischke, D.N.P. Murthy, *Case studies in Reliability and Maintenance*, 2nd Edition, John Wiley and Sons,2003
3. Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, *Maintenance, Replacement and Reliability: Theory and Applications*, 3rd Edition, CRC/Taylor and Francis,2006
4. B. S. Dhillon, Chanan Singh , *Engineering Reliability – New Techniques and Applications*, John Wiley and Sons,1981
5. B. S. Dhillon, *Engineering Maintainability*, Prentice Hall of India,1999

Online Learning Resources:

1. NPTEL Course on Introduction to Reliability Engineering by Prof. Neeraj Kumar Goyal, IIT Kharagpur Link: https://onlinecourses.nptel.ac.in/noc23_ge20/preview
2. NPTEL Course on Statistical Learning for Reliability Analysis by Prof. Monalisa Sarma, IIT Kharagpur Link:https://onlinecourses.nptel.ac.in/noc25_cs139/preview

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Ashta - 416301, Dist. : Sangli, Maharashtra
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Department of Mechanical Engineering
Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE512, Product Design and Development**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	1	-	-	4		

Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the principles and processes of product design and development by identifying customer needs, generating design concepts, evaluating alternatives, and considering manufacturing, cost, and lifecycle requirements to create innovative and practical solutions.
CO2	Apply the principles and processes of product design and development to identify customer needs, generate creative concepts, evaluate alternatives, and design manufacturable products while considering lifecycle, cost, and market requirements.
CO3	Analyze product design and development processes to identify customer needs, evaluate design concepts, optimize decision-making, and develops manufacturable solutions considering lifecycle, cost, and market constraints.
CO4	Evaluate product design and development strategies to prioritize customer needs, assess design alternatives, and validate manufacturable solutions considering lifecycle, cost, sustainability, and market dynamics.
CO5	Design innovative engineering products by applying systematic design processes, creative thinking, and product lifecycle considerations, ensuring compliance with standards, societal needs, manufacturability, and cost-effectiveness.

Syllabus:

Module	Contents	Lecture Hours
I	**Fundamentals in Engineering Design and Product-Development:** Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.	7
II	**Problem Definition and Need Identification:** Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality- product design specification-case studies.	8
III	**Concept Generation Methods and Tools:** Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition –functional representation –morphological methods-TRIZ- axiomatic design.	8
IV	**Decision Making, Concept Selection and Product Architecture:** Decision making –decision theory –utility theory –decision trees –concept evaluation methods –Pugh concept selection method- weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture –steps in developing product architecture.	7
V	**Product Design Considerations:** Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost overhead costs – activity-based costing –methods of developing cost estimates – manufacturing cost – value analysis in costing, product quality standards.	7

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VI	**Design for Manufacturing:** Product design for assembly, Design guidelines for metallic and non-metallic products to be manufactured by different processes such as casting, machining, injection moulding etc., Rapid prototyping, needs, advantages, working principle of SLA, LOM and SLS.	8
	Total Lecture Hours	45

Text Books:

1. George E.Dieter, Linda C.Schmidt, *Engineering Design*, 4th Edition, McGraw-Hill International Edition,2013
2. Kevin Otto, Kristin Wood, *Product Design*,5th Edition, Pearson Education,2014
3. Clive L.Dym, Patrick Little, *Engineering Design: A Project-based Introduction*,3rd Edition, John Wiley & Sons,2009,

References:

1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, *Product Design and Development*,5th Edition, Tata McGraw-Hill Education,2017
2. Yousef Haik, T. M. M. Shahin, *Engineering Design Process*,2nd Edition, Cengage Learning,2010
3. A. K. Chitale, R. C. Gupta, *Product Design and Manufacturing*,3rd Edition, Prentice-Hall of India Pvt.Limited,2011

Online Learning Resources:

1. NPTEL course on Product Design and Development by Prof. Inderdeep Singh. IIT Roorkee
   Link: https://onlinecourses.nptel.ac.in/noc25_me121/preview
2. You Tube video on Product Design and Development.
   Link: https://www.youtube.com/watch?v=mvs1An9Gei4

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**PE**
Course Code, Course Title	**0DEPE513, Reverse Engineering**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	1	-	-	4		

Examination Scheme (Marks)	**Theory**				**Practical**		
	MSE	**TA**	**ESE**		**CIA**	**ESE**	
	40	20	40		-	-	

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain scope of reverse engineering in product development.
CO2	Apply various techniques of reverse engineering along with software's in prototyping
CO3	Analyze the process of the reverse engineering.
CO4	Integrate data management system in the reverse engineering.
CO5	Use the formal and structured methods in reverse engineering
CO6	Visualize process of reverse engineering in real life case studies.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction to Reverse Engineering:** History of reverse engineering, Scope of reverse engineering, tasks in reverse engineering, Domain analysis, Process of duplicating.	6
II	**Tools for Reverse Engineering:** Functionality, Dimensional developing technical data, Digitizing techniques, Construction of surface model, Solid-part, Materials Selection, Characteristics evaluation, Software and applications, Prototyping, Verification.	7
III	**Concepts in Reverse Engineering:** Preserving and preparation for the four-stage process, Evaluation and verification, technical data generation, Data verification, Project implementation.	8
IV	**Data Management:** Data reverse engineering, three data reverse engineering strategies, Definitions, Organization data issues, Software application, finding reusable software components, recycling real-time embedded software, Design experiments to evaluate a reverse engineering tool, Rule based detection for reverse Engineering user interfaces, Reverse engineering of assembly programs - A model-based approach and its logical basics.	9
V	**Integration:** Cognitive approach to program understated, integrating formal and structured methods in reverse engineering, integrating reverse engineering, reuse and specification tool environments to reverse engineering, coordinate measurement, feature capturing, surface and solid members.	7
VI	**Reverse Engineering in product development and Case Studies:** Fundamental approach is that reverse engineering and teardowns offer a new better paradigm for design instruction, permitting a modern learning cycle of experience, hypothesis, understanding, and then execution; Applications of contemporary technologies; Exploration of the boundaries of design methodology; Decision making for real product development; Case studies like Reverse Engineering of a Turbocharger Component includes 3D scanning of the original component using laser or structured light scanning, Reconstruction of a Wind Turbine Blade Profile, Biomedical Implant Design, Aircraft Bracket Reverse Engineering etc.	8
	Total Lecture Hours	**45**

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Text Books:
1. Katheryn, A. Ingle, *Reverse Engineering*,1st Edition, McGraw-Hill, 1994
2. Aiken, Peter, *Data Reverse Engineering*, McGraw-Hill, 1996
3. Linda Wills, *Reverse Engineering*, 1st Edition, Kluiver Academic Publishers, 1996
References:
1. T J Biggerstaff, *Design Recovery for Maintenance and Reuse*, IEEE Corpn., July1991
2. S. Rugaban, *White paper on RE, Technical Report*, Georgia Instt. of Technology,1994
3. Donald R. Honsa, *Co-ordinate Measurements and Reverse Engineering, Technical Report*, American Gear Manufacturers Association,2008
4. Kevin N. Otto, Kristin L. Wood, *Product Design: Techniques in Reverse Engineering and New Product Development*, 1st Edition, Prentice Hall, 2001

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Department of Mechanical Engineering
Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester I					**Category**	**MA**
Course Code, Course Title	**0DEMA514, Research Paper Writing**					**Type**	**T2**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	2	-	-	-		2	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		-	50	-		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Identify and implement key components of a well-structured research paper by recognizing and applying appropriate formatting, paraphrasing techniques, and plagiarism prevention strategies
CO2	Apply fundamental writing principles by structuring sentences and paragraphs effectively while eliminating ambiguity and redundancy, given a poorly structured passage
CO3	Demonstrate the ability to write different sections of a research paper effectively by developing a well-written title, abstract, introduction, and literature review following academic
CO4	Utilize appropriate academic phrases and proofreading techniques for effective research communication by applying useful academic phrases and performing self-editing to enhance clarity and precision

Syllabus:

Module	Contents	Lecture Hours
I	Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	5
II	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts.	5
III	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	5
IV	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature	5
V	skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions	5
VI	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	5
	Total Lecture Hours	**30**

Text Books:

1. Goldbort R, *Writing for Science*, Yale University Press, 2006
2. Day R, *How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006
3. Highman N, *Handbook of Writing for the Mathematical Sciences*, SIAM, Highman'sbook, 1998
4. Adrian Wallwork, *English for Writing Research Papers*, Springer New York Dordrecht Heidelberg London, 2011

Online Learning Resources:

1. NPTEL course on 'English for Research Paper Writing, by By Dr. Shoba. K. N , National Institute Of Technical Teachers Training And Research, Chennai, https://onlinecourses.swayam2.ac.in/ntr25_ed81/preview
2. Udemy course on "How to Write a Research Paper? | Masterclass for Beginners", Link:https://www.udemy.com/course/how-to-write-a-research-paper-masterclass-for-eginners/?couponCode=MT180825A
3. Coursera course on "Project: Writing a Research Paper",Tamy Chapman & co., Link:https://www.coursera.org/learn/academic-writing-capstone

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PC**
Course Code, Course Title	**0DEPC515, Advanced Finite Element Methods**					**Type**	**LIT1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	-	4	-		5	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		50	50

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the fundamental concepts of theory of elasticity and software implementation for static structural and thermal concepts with FEM approach.
CO2	Apply the finite element formulations for 1D and 2D problems by using finite element method.
CO3	Compute unknown variables in structural and thermal analysis by using finite element formulations.
CO4	Analyze and interpret results of 1D, 2D and 3D problems by using the appropriate analytical methods and numerical tools.

Syllabus:

Module	Contents	Lecture Hours
I	**Fundamental Concepts:** Introduction, Past, present and future of FEA, Stresses and Equilibrium, Boundary Conditions, Strain-Displacement relations, Stress-Strain Relations, Potential energy and equilibrium, Galerkins method, Von-Mises stresses.	8
II	**One Dimensional Problem:** Introduction, Finite element modeling (element division, numbering scheme),coordinates and shape functions, the potential energy approach(element stiffness matrix, force terms), Galerkin approach (element stiffness matrix, force terms),Assembly of the global stiffness matrix and load vector, properties of K, the finite element equations; treatment of boundary conditions(types of boundary conditions), elimination approach.	8
III	**Two-Dimensional Problems using Constant Strain Triangles:** Introduction, finite element modelling, Constant Strain Triangle (CST), Iso-parametric representation, potential-energy approach ,element stiffness, force terms, Galerkin approach, stress calculations, problem modelling and boundary conditions.	7
IV	**Analysis of Trusses:** **Trusses:**-Plane trusses, Local and Global coordinate systems, formulas for calculating L and M, element stiffness matrix, Stress Calculations, Assembly of global stiffness matrix.	7
V	**Analysis of Thermal Problems:** Introduction, steady state heat transfer, One dimensional heat conduction, One dimensional heat transfer in thin fins, Two-dimensional steady state heat conduction.	7
VI	**Computer Implementation of the Finite Element Method:** **Pre-processing** : Model definition–nodal coordinate s element connectivity, material and element type and property definitions, type of analysis(static/modal), loading and boundary conditions. Meshing techniques- free and mapped meshing, Quality checks – aspect ratio, warp angle, skew, distortion, stretch, included angle, taper **Processing**: Element level calculations, Equation assembly, Equation solver (sparse solvers, factorization, numerical/computational issues) **Post Processing**: Strain and stress recovery (integration and nodal points), interpretation of results (results validation and data interpretation) and design modification.	8
	Total Lecture Hours	45

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List of Experiments with CO Mapping

S. No	Title / Topic of the Experiment	CO Mapped
1	Static structural analysis of 1D Bar using ANSYS.	2,4
2	Static structural analysis of Beam using ANSYS.	1,3
3	Static structural analysis of Truss using ANSYS.	1,3
4	Static structural analysis of 3D component using ANSYS Workbench. (Mesh Convergence using Parameters Set).	2,4
5	Static structural analysis of 3D component with Stress concentration geometry using ANSYS Workbench. (Define Path to find results)	2,4
6	Steady state and Transient thermal analysis of component using ANSYS.	2,4
7	Structural and thermal combination analysis	2,4
8	Buckling analysis of column using ANSYS.	1,4
9	Modal analysis of component using ANSYS.	1,4
10	Case studies on optimization	1,4
Total Practical Sessions	**30** **Total Practical Hours**	**60**

Text Books:

1. Chandrupatla T. R, *Finite Elements in Engineering*, 2nd Edition, PHI, 2007
2. Rao S. S, Finite Elements Method in Engineering,4th Edition, Elsevier, 2006
3. U.S. Dixit, Finite Element Analysis for Engineers, 4th Edition, Ginage, 2011
4. Cook R. D, Concepts and Application of Finite Elements Analysis, 4th Edition, Wiley & Sons, 2003
5. J.N.Reddy, Finite Element Method,3rd Edition, McGraw Hill International Edition, 2006
6. Zeinkovich, The Finite Element Method for Solid and Structural Mechanics, 6th Edition, 2007

References:

1. Saeed Moaveni, Finite Element Analysis Theory and Application with ANSYS,3rd Edition, Prentice Hall, 2015
2. Huei-HuangLee, Finite Element Simulations with ANSYS Workbench 14 Perfect Paperback – Import, 11th June 2012,1st Edition, Schroff DevelopmentCorp., 2012
3. Kent L. Lawrence, Ansys Workbench TutorialRelease 14: Structure & Thermal Analysis, 2nd Edition, Schroff DevelopmentCorp., 2012
4. Srinivas Paleti, Finite Element Analysis Using Ansys 11.0 Paperback,1st Edition, PHI, 2010

Online Learning Resources:

1. NPTEL Course on Finite Element Methods by Dr. Tramal Pramanick NIT Calicut
   Link: https://onlinecourses.swayam2.ac.in/cec25_ma27/preview
2. NPTEL course on Basics of Finite Element Analysis by Prof. Nachiketa Tiwari, IIT Kanpur.
   Link: https://onlinecourses.nptel.ac.in/noc25_me158/preview

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Department of Mechanical Engineering

Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PC**
Course Code, Course Title	**0DEPC516, Advanced Vibration and Acoustics**					**Type**	**LIT2**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	-	2	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		50	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the causes and effects of noise and vibrations in mechanical systems and understand the role of damping ,stiffness and inertia in mechanical system.
CO2	Develop schematic models for physical systems and formulate governing equations of motion and to determine response of vibration.
CO3	Calculate sound parameters, free and forced vibration responses of multi degree freedom systems using modal analysis.
CO4	Measure the different vibration parameters using FFT analyzer.
CO5	Analyze rotating and reciprocating systems and design machine supporting structures, vibration isolators and absorbers.

Syllabus:

Module	Contents	Lecture Hours
I	**Two degree of freedom systems:** Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion, Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial conditions, coupled pendulum, free vibration response case studies, Forced vibration response, Automobile as a two degree of freedom system –bouncing and pitching modes undamped vibration absorbers, Analysis and design of damped vibration absorbers.	8
II	**Multi degree of freedom systems:** Introduction, Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh's damping, Introduction to experimental model analysis.	7
III	**Continuous systems:** Introduction to continuous systems, discrete vs continuous systems. Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method	8
IV	**Fundamentals of sound :** Sound propagation in different fields, simple and complex sound waves, relation between sound power, sound intensity and sound pressure levels, decibel units, addition and subtraction of SPL, sound frequency analysis.	8
V	**Fundamentals of noise control:** Criteria for noise control, noise criteria related to damage risk, noise control at source, at path and at receiver, sound absorption and transmission coefficients, acoustic absorption and transmission loss.	7
VI	**A.Noise and vibration measurement:** Instrumentation for noise measurement and its analysis, Instrumentation of vibration measurement and analysis, Natural frequency testing , Modal analysis	8

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	Case studies **B. NVH concept and its importance:** NVH in cars	
	Total Lecture Hours	**45**

List of Experiments with CO Mapping

S. No	Title / Topic of the Experiment	CO Mapped
1	Experiment on motion transmissibility of the system	4,5
2	Experiment on vibration absorber	5
3	Natural frequency estimation of two-degree freedom system	3,4
4	Natural frequency estimation of continuous beam	3,4
5	Sound power estimation of sound source at different distances	5
6	Vibration frequency analysis by using FFT analyzer	4
7	Fault diagnosis of rotating machine by using FFT analyzer	4,5
8	Octave band analysis of the machine to identify predominant sound frequencies	5
9	Case studies on vibration control of system	4,5
10	Case study on sound reduction	5
11	Experiment on shakers table	4,5
Total Practical Sessions	**15** **Total Practical Hours**	**30**

Text Books:

1. R. Venkatachalam, Mechanical Vibrations,1st Edition, Prentice Hall of India,2014
2. L. DEirovich, *Elements of Vibration analysis*, 2nd Edition, Tata Mc-Graw Hill,2007
3. W.T., Thompson, *Theory of Vibration*, CBS Publishers,2006
4. S. S. Rao, *Mechanical Vibrations*,4th Edition, New Age International (P) Ltd., New Delhi,2003

References:

1. Shriniwasan P., *Mechanical Vibration Analysis*, Tata McGraw Hill,1982
2. C. Sujatha, *Vibration and Acoustics*, Tata McGraw Hill,2010
3. J.S. Rao and K.Gupta, *Theory and Practice of Mechanical Vibrations*, Wiley Eastern Ltd.,1991

Online Learning Resources:

1. NPTEL course on Fundamentals of Acoustics by Prof. Venkata R. Sonti | IISc Bangalore
   Link: https://onlinecourses.nptel.ac.in/noc25_me159/preview
2. NPTEL course on Elements of Mechanical Vibration by Prof. Ashish K Darpe, IIT Delhi
   Link: https://onlinecourses.nptel.ac.in/noc25_ae17/preview

Experiments that may be performed through virtual labs:

S. No.	Experiment Name	Experiments Links
01	Natural frequency estimation of continuous beam	https://va-coep.vlabs.ac.in/exp/cantilever-modal-analysis/

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE517, Fracture Mechanics**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Differentiate the design approach and fracture mechanics approach
CO2	Solve the numerical of design problems using the fundamentals of LEFM
CO3	Analyze the suitability of fracture testing specimen and evaluate the fracture toughness of the material
CO4	Apply the Fail-Safe principle and predict the service life of to the components undergoing fatigue failure
CO5	Understand the difference in theories of LEFM and EPFM and apply EPFM theories to find out fracture toughness of ductile materials

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction:** Difference in the approach of design criteria and fracture mechanics criteria, Fundamentals of solid mechanics, types of fracture: ductile and brittle, Estimation of theoretical strength.	8
II	**Linear Elastic Fracture Mechanics – I:** Griffith Fracture Criteria- the energy approach, energy release rate (G) and Resistance (R), Difficulties in Griffith's theory, Necessary and sufficient conditions for fracture, Irwin and Orowan extension of Griffth's theory to ductile solids, R-curve in plane strain and plane stress,	7
III	**Linear Elastic Fracture Mechanics – II:** Irwin's Fracture Criteria- the stress intensity approach, definition of Stress Intensity Factor (SIF), Approximate plastic zone shapes in plane strain and plane stress for Mode-I and Mode-II loadings, plastic zone shape in Mode-III, Accounting for redistribution of load, Irwin's model, Plastic zone length in plane stress and plane strain, small scale yielding approximations, Motivation of Dugdale model. Equivalence between SIF and G, Interrelationship between KI and GI by closing an incremental crack extension. Evaluation of SIF for various geometries.	8
IV	**Fracture Toughness Testing:** Minimum thickness for fracture toughness specimen based on plastic zone, Fracture testing – early attempts, Fracture toughness as a function of specimen thickness, Requirements of the test, Candidate fracture toughness, Compact tension and three point bend specimens, Some important standards and practices: E399-06, B 645-07, E 1820-99, and E 1823-96.	7
V	**Crack Initiation and Life Estimation:** Crack growth curve, Paris law, Validation of Paris law, Threshold stress intensity factor, Definition of stress ratio, Sigmoidal curve: Region I, Region II and Region III, mean stress influence and environmental effects on crack growth rate. Review of Paris law, Crack closure: Designer's approach, Empirical relations of ΔK eff	7
VI	**Elastic Plastic Fracture Mechanics:** Eshelby's line integrals, J-integral, Path independence of J-integral, Analytical evaluation of J-integral for the DCB specimen, Graphical interpretation of J, Importance of strain history in elasto-plastic analysis, Extension of NLEFM to EPFM, CTOD: Definition, Estimation of CTOD from: Irwin's result; Dugdale's work, J and CTOD, Interrelationship between fracture parameters.	8
	Total Lecture Hours	45

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Text Books:

1. Prashant Kumar, *Elements of Fracture Mechanics*, Tata McGraw Hill,2009
2. D. Broek *Elementary Engineering Fracture Mechanics*, Kluwer Academic Publishers,1986
3. K. R.Y.Simha, *Fracture Mechanics for Modern Engineering Design*, Universities Press (India) Limited,2001
4. E. E. Gdoutos, Fracture Mechanics: An Introduction, Kluwer Academic Publishers,1993

References:

1. T.L. Anderson, *Fracture Mechanics - Fundamentals and Applications*, Taylor and Francis Group,2005
2. M.F. Kanninen and C.H. Popelar, *Advanced Fracture Mechanics*, Oxford University Press,1985
3. Hertzberg, R.W., *Deformation and Fracture Mechanics of Engineering Materials*, John Wiley and Sons, Inc.,1996

Online Learning Resources:

1. NPTEL course on Engineering Fracture Mechanics by Prof. K. Ramesh, Dr. Hariprasad M P, IIT Madras
   Link: https://onlinecourses.nptel.ac.in/noc25_me109/preview
2. You Tube video on Introduction to Fracture Mechanics
   Link: https://www.youtube.com/watch?v=rKi6_ibjVPA

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE518, Vehicles Dynamics**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the fundamental principles governing vehicle dynamics and their influence on road vehicle performance.
CO2	Evaluate acceleration and braking performance by analyzing power limitations, braking efficiency, and road friction parameters.
CO3	Analyze ride comfort by examining road loads, vibrations, and vehicle response properties under dynamic conditions.
CO4	Design strategies for optimizing vehicle suspension systems to improve handling, comfort, and stability while reducing maintenance requirements.
CO5	Investigate emerging trends in vehicle dynamics, including electric vehicle dynamics, autonomous vehicle stability, and active suspension technologies.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction to Vehicle Dynamics:** Vehicle Control Loop: Open-loop and closed-loop dynamics, Vehicle Coordinate Systems and motion variables, Forces Acting on a Vehicle: Static and dynamic axle loads, Aerodynamic Forces and their impact on vehicle stability, Hitch Forces and weight distribution – Case studies and problem-solving.	7
II	**Acceleration and Braking Performance:** Power-Limited Acceleration and tractive force analysis, Aerodynamic Resistance, Wind Resistance, and rolling resistance, Braking Dynamics: Braking force distribution, braking efficiency, Disc vs. Drum Brakes, front/rear wheel braking, four-wheel braking, Emergency Braking, ABS, Regenerative Braking in electric vehicles – Problems.	8
III	**Road Loads and Aerodynamics:** Mechanics of Aerodynamic Pressure Distribution, Lift, Drag, Spoilers, and aerodynamic stability (Yaw, Pitch, Roll), Crosswind Sensitivity and its impact on vehicle control, Rolling Resistance and fuel economy optimization strategies, Effect of Tire Slip, Pressure, and Temperature on road loads – Problems.	8
IV	**Ride Comfort and Vibration Analysis:** Excitation Sources: Road roughness, wheel assembly imbalance, driveline vibration, Suspension Dynamics: Stiffness, damping, and isolation effects, Road-Tire Friction and its role in vehicle ride quality, Dynamic Response of Tires: Rigid body bounce, pitch motion, Human Perception of Ride Comfort and NVH (Noise, Vibration, Harshness) Analysis.	8
V	**Steady-State Cornering and Vehicle Stability:** Low-Speed and High-Speed Cornering characteristics, Tire Cornering Forces, Slip Angle, and cornering stiffness, Under steer, Over steer, and neutral steer conditions, Yaw Velocity Gain, Static Margin, and critical speed evaluation, Effects of Tractive Forces and Load Transfer on cornering performance.	7
VI	**Suspension Systems and Advanced Technologies:** Suspension Types: Solid axle, independent, multi-link, trailing arm, Anti-Squat, Anti-Pitch, and Anti-Dive suspension design, Active Suspension Systems: Hydraulic, electromagnetic, and	7

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	adaptive control, Suspension Tuning for performance optimization, Emerging Trends: Air suspension, semi-active and fully active suspension, magneto rheological dampers.	
	Total Lecture Hours	**45**

Text Books:

1. Rao V Dukkipati, Road Vehicle Dynamics, Springer,2008
2. J. Y. Wong ,Theory of Ground Vehicles, John Wiley and Sons Inc., New York,2001
3. Amitosh D, Vehicle Dynamics, Galgotia Book Ltd,2010
4. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, Society of Automotive Engineers,2012

References:

1. J.G. Giles, Steering, Suspension and Tyres, Illiffe Books Ltd,2007
2. Blundell, M. and Harty, D., The Multi body Systems Approach to Vehicle Dynamics, Elsevier Publications,2011
3. Hans Pacejka, Tyre and Vehicle Dynamics, , SAE Publications,2nd Edition,2011
4. Julian Happian-Smith, An Introduction to Modern Vehicle Design, Butterworth-Heinemann,2002
5. Hans B Pacejka, Tyre and Vehicle Dynamics, Elsevier Ltd,3rd Edition,2012.
6. Werner and Kar, Ground Vehicle Dynamics, Springer Berlin Heidelberg,2008

Online Learning Resources:

1. NPTEL Course on Introduction to Electric and Hybrid Electric Vehicle, by Dr. R. N. Patel and Dr. Lalit Kumar Sahu, Chhattisgarh Swami Vivekanand Technical University, Bhilai
   Link: https://onlinecourses.swayam2.ac.in/nou25_ec13/preview
2. You tube lectures on Engineering Design- Vehicle Dynamics.
   Link:https://www.youtube.com/watch?v=LZ82iANWBL0&list=PLbMVogVj5nJTW50jj9_gvJmdwFWHaqR5J&pp=iAQB

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Department of Mechanical Engineering
Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE519, Robotics**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	1	-	-	4		
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Apply the fundamental principles of robotics to classify robots based on configuration, degree of freedom, and application requirements.
CO2	Solve kinematics and dynamics problems in robotic systems, including forward and inverse kinematics, to analyze robot motion and workspace.
CO3	Implement appropriate control strategies, such as PID and adaptive control, to plan trajectories and ensure precise motion in robotic applications.
CO4	Utilize sensors, vision systems, and perception techniques, including SLAM and sensor fusion, for real-time robot navigation and decision-making.
CO5	Integrate artificial intelligence and machine learning methods into robotic systems for applications like motion planning, object recognition, and human-robot interaction.

Syllabus:

Module	Contents	Lecture Hours
I	**Fundamentals of Robotics:** Introduction to Robotics: Definition, History, and Evolution of Robotics, Components of a Robotic System: Sensors, Actuators, Controllers, End Effectors, Classification of Robots: Based on Configuration (Cartesian, Cylindrical, Spherical, SCARA, Articulated), Applications, and Degrees of Freedom Kinematics of Robots: Forward Kinematics, Inverse Kinematics, Workspace, and Redundancy Applications of Robotics: Industrial, Medical, Service, Military, and Space Robotics.	7
II	**Robot Dynamics and Control:** Robot Dynamics: Newton-Euler and Lagrange Methods for Dynamic Modelling, Trajectory Planning: Joint Space and Cartesian Space Trajectories, Control Systems: Proportional-Derivative (PD), Proportional-Integral-Derivative (PID), and Adaptive Control Motion Planning: Configuration Space, Path Planning Algorithms (A*, RRT, PRM), Control Strategies in Industrial Robots.	7
III	**Sensors and Perception in Robotics:** Types of Sensors in Robotics: Proximity, Force/Torque, Vision, LIDAR, IMU, GPS, Vision Systems: Image Processing, Camera Calibration, Object Recognition, Feature Detection, Sensor Fusion: Kalman Filters and Extended Kalman Filters for Data Integration, Perception Algorithms: SLAM (Simultaneous Localization and Mapping) and Obstacle Detection, Industrial Applications: Automated Inspection, Navigation.	8
IV	**Robot Programming and Simulation:** Robot Programming Languages: RAIL, VAL, RAPID, KUKA KRL, and ROS (Robot Operating System) Basics, Simulation Tools: MATLAB/Simulink, Gazebo, V-REP, and Webots, Robot Programming Techniques: Online and Offline Programming, Programming Industrial Robots: Case Studies with ABB, KUKA, or FANUC Robots, Task Automation: Programming for Pick-and-Place, Welding, and Painting Applications.	8
V	**Artificial Intelligence and Machine Learning in Robotics:** AI in Robotics: Role of AI, Knowledge Representation, and Reasoning, Machine Learning Basics: Supervised, Unsupervised, and Reinforcement Learning, Neural Networks in Robotics:	8

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	Applications in Motion Control and Vision Systems, Robotics and Natural Language Processing: Human-Robot Interaction and Voice Commands, Case Studies: AI-Enabled Robots in Autonomous Vehicles, Healthcare, and Collaborative Robotics.	
VI	**Advanced Topics in Robotics and Applications:** Humanoid Robots: Design, Dynamics, and Control, Collaborative Robots (Cobots): Safety, Control Strategies, and Use Cases, Micro and Nano Robotics: Fabrication Techniques, Applications in Aerial sector, industrial applications and agriculture drones. Ethics and Standards in Robotics: Social and Legal Aspects, ISO Standards for Industrial Robots, Emerging Trends: Soft Robotics, Swarm Robotics, Underwater Robotics, and Space Robotics.	**7**
	Total Lecture Hours	**45**

Text Books:

1. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, *Robotics: Control, Sensing, Vision, and Intelligence*,1st Edition, McGraw-Hill,1987
2. John J. Craig, *Introduction to Robotics: Mechanics and Control*,4th Edition, Pearson,2017
3. Mark W. Spong, *Robot Modeling and Cont*rol,1st Edition, Wiley,2006
4. Bruno Siciliano, *Robotics: Modelling, Planning and Control*,2nd Edition, Springer,2010
5. Roland Siegwart, *Introduction to Autonomous Robots*,2nd Edition, MIT Press,2011

References:

1. Bruno Siciliano, *Handbook of Robotics*,2nd Edition, Springer,2016
2. Kevin M. Lynch, *Modern Robotics: Mechanics*, Planning, and Control,1st Edition, Cambridge University Press,2017
3. Alan Winfield, *Robotics: A Very Short Introduction*,1st Edition, Oxford University Press,2012

Online Learning Resources:

1. NPTEL Course on Introduction to Robotics, by Prof. Asokan T Prof. Balaraman Ravindran Prof. Krishna Vasudevan, IIT Madras,
   Link: https://nptel.ac.in/courses/107106090
2. NPTEL course on Industrial Robotics: Theories for Implementation by Prof. Arun Dayal Udai, IIT, ISM Dhanbad
   Link: https://onlinecourses.nptel.ac.in/noc25_me161/preview

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Course Information:							
Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE520, Condition Monitoring & Fault Diagnosis**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the types of machinery maintenance ,condition monitoring and fault diagnosis procedures
CO2	Apply the condition monitoring technique to evaluate and predict the condition of the machine
CO3	Analyze the signals of machine parameters to pinpoint the machinery faults
CO4	Evaluate unbalance condition, grade of unbalance of a rotor and carry out site balancing
CO5	Rectify the mechanical faults in the machinery to reduce vibration , noise and temperature of the machine

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction to Machinery maintenance:** Importance of machinery maintenance. Types of machinery maintenance- Break down maintenance, Time base maintenance, Condition based maintenance. Concept of preventive maintenance using condition monitoring, Machinery monitoring parameters-vibration, Noise, Oil debris, Temperature, wear	7
II	**Vibration condition monitoring:** Concept of vibration monitoring. Principle of vibration condition monitoring, Selection of vibration parameters for condition monitoring. Procedure of vibration monitoring, vibration monitoring locations, vibration monitoring data sheets, Vibration severity criteria ISO:2372, ISO:10816, ISO10816-3, Interpretation of machine condition. Time interval for vibration monitoring	8
III	**Machinery fault diagnosis:** Mechanical faults in machines and their vibrational characteristics: -Unbalance, misalignment, looseness, faulty bearings, faulty gears, critical speed of the shaft, foundation problems. Procedure of fault diagnosis: -Trend analysis, Frequency spectrum analysis and phase analysis for fault diagnosis	8
IV	**Balancing of machinery rotors:** Single plane unbalance, two plane unbalance Instruments for balancing the rotors at site, Single plane balancing of rotor using vector method, Single plane and two plane balancing by using FFT Analyzer. Selection of balance mass, Splitting of balance mass, Balancing grade and tolerance.	8
V	**Alignment of shafts and Rectification of bearing problems:** Procedure of alignment of shafts by dial gauge and filler gauge, use of laser alignment, Alignment of machinery shafts subjected to thermal distortion Bearing mounting procedure, Rectification of looseness and bearing misalignment.	7
VI	**A]Miscellaneous monitoring techniques:** Temperature monitoring, Thermography, Thermal image analysis, Oil debris analysis, Procedure of oil debris analysis. Ferometry, Magnetic plugs. Noise monitoring and analysis **B] Machine learning and Artificial intelligence for condition monitoring:** Introduction to machine learning and artificial intelligence techniques applied to the condition monitoring and predictive maintenance of industrial machines, IoT devices for predictive maintenance	7

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Total Lecture Hours	**45**

Text Books:

1. Amiya Rajan Mohenty, *Machinery Condition Monitoring*, 1st Edition,
2. Ramesh Kumar, *Condition Monitoring of Industrial Machinery*, 1st Edition, LAMBERT Academic Publishing Co.
3. Ashok Nandi , Hosameldin Ahamad, *Condition monitoring with Vibration Signals*, 1st Edition,2020
4. Yilun Shang and Shiyu Zhou., *Artificial Intelligence for Predictive Maintenance*

References:

1. R. A. Collacott, *Mechanical Fault Diagnosis and Condition Monitoring*, 1st Edition, Champman & Hall, 1997.
2. Shilong Sun, Changqing Shen, Dong Wang, *Machine Health Monitoring and Fault Diagnosis Techniques*, 2nd Edition, MDPI, 2023
3. Thomas Vaimann,, Anders Bandt, *Advances in Machine Fault Diagnosis*, 2nd Edition, MDPI, 2020

Online Learning Resources:

1. NPTEL course on Condition Monitoring and Maintenance Management By N. Venkateshwarlu Indira Gandhi National Open University, New Delhi
   Link: https://onlinecourses.swayam2.ac.in/nou25_me11/preview
2. You Tube Lectures on Condition Monitoring and Fault Diagnosis of Rotating Machines
   Link: https://www.youtube.com/watch?v=wRRbY8HgU9Y

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE521, Machine Tool Design**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Determine the basic needs of the machine tool component design.
CO2	Interpret the knowledge of designing the gear boxes for stepped drive systems in the machine tools.
CO3	Coherence the various methods of controls of the machine tools.
CO4	Construct and design the various elements of machine tool systems.
CO5	Distinguish the Various controls and their importance in every field.

Syllabus:

Module	Contents	Lecture Hours
I	**Classification and Kinematics of Machine Tools:** Classification of machine tools on their method of operation, precision of working and rate of production etc., Consideration and trends of design of machine tools, Classification of Kinematic systems used for motion of various elements of machine tools. Kinematic chains for feed motion of various elements of machine tools	7
II	**Kinematics of Machine Tools:** Design consideration for accuracy and precision working, Selection of cutting speed and speed range, method of speed regulation, stepped, step-less drives, mechanical, Electrical and Hydraulic methods of speed regulation and their comparison. Step-Less Speed Drives: Classification and different methods and their comparison. Working Principles of step-less drives.	8
III	**Stepped drives of machine Tools:** Gear drive, gear box design, graphical representation of gear box operation with ray diagram, structure diagram and deviation diagram. Gear Teeth Calculations.	8
IV	**Design Considerations for components:** Considerations used in design for strength, rigidity - static and dynamic stiffness and life of various elements of machine tools such as bed and frames, slides and tables, spindles and screws etc., Various types of spindles, spindle support, friction and antifriction slide ways used in hydrostatic and aerostatic ways. Hydro and aerostatic bearing. Friction and Antifriction screws	7
V	**Controls and Automation:** Various control introduced on machine tools and their importance, various systems such as mechanical, electrical, electronic, optical, pneumatic, and hydraulic. Systems used for position control, Their relative merits and demerits, Their application in automation, economics for automation, various stages of automation	8
VI	**Numerical Control:** N.C. system for drives, feed- back device, counting devices, programming of N.C. machines tools, its concept and types. Manual programming, post processor, adaptive control of machine tool, its concept and types, Trends, and developments in machine tool design. Design consideration of Special Purpose Machine and Specific Purpose Machines	7
	Total Lecture Hours	45

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Text Books:
1. M.F.Spotls, Mechanical Analysis,1st Edition, Prentice Hall publications,2000
2. Robert., L.Norton, Design of Machinery –An introduction to the Synthesis and Analysis of Machines and Mechanisms,4th Edition, MacGraw Hills International and Publications,2001
3. J. F. Harvey, Pressure Vessel Design,3rd Edition, Van Nostrand Reinhold,2007
References:
1. K.C.Kapur & L.R Lambesson, Reliability in Engineering Design",2nd Edition, Wiley student education edition,1997
2. P.Orlo, Machine Design Vol. I,1st Edition, Mosco Publication,1995
3. E.Balaguruswami, Reliability Engineering,2nd Edition, Tata MacGraw Hills Publications, 1984
Online Learning Resources:
1. You Tube video on Machine Tool Gearbox Link: https://www.youtube.com/watch?v=MnFZOBnxv9E

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE522, Machining Dynamics**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	1	-	-	4		
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the basics of mechanistic modelling of metal cutting operations and gain a qualitative understanding of the different parameters affecting cutting processes.
CO2	Explain the interaction between the machining process and the vibration behaviour of machine tools.
CO3	Identify machine tool dynamics testing equipment and machining process monitoring equipment.
CO4	Diagnose machining process-related issues, including becoming familiar with phenomena unique to high-speed machining.
CO5	Solve numerical analysis related to machining and dynamics of machine tools.

Syllabus:

Module	Contents	Lecture Hours
I	**Machining process modelling and analysis:** Format, grading, philosophy, policies, goals, expectations; Introduction to machining terminology, Static and dynamic models of machining; Mathematical approach to machining process modelling, Fundamental process geometry, Merchant's theory, Velocity relations and force circle diagrams, Shear plane and rake face stress analysis; Power, machinability and cutting energy analysis, Force modelling and understanding size effect in machining, Tool orientation, rake and flow angles, Chip ratio, Relation of 3D geometry to 2D orthogonal process, Force modelling, Equivalent lead angle and simplifying approximations; More complex distributed models. Process force modelling and summary of turning, Differences between single point turning and multi-point milling processes, mechanistic identification of cutting constants.	9
II	**Review of free and force vibration analysis:** SDOF systems; FBDs; Formulation of EOM using different methods in different domains; Free vibrations, Damped free vibrations Response to initial conditions, Forced vibrations; Steady-state analysis; Different damping models, Modelling undamped free vibrations; EOMs for MDOF systems, The solution to eigenvalue problems for MDOF systems; Mode shape descriptions, Forced response analysis; Modeling machine tools as MDOF systems.	7
III	**Experimental model analysis:** Modal transformations; Proportional systems; Special characteristics of modal domains – linearity; Orthogonality, Response function measurement techniques; Excitation of structures; Basics of measurements and digital signal processing (DSP), Working across multiple domains (time-frequency); FFT analysis, Extraction for SDOF/MDOF systems; Peak picking methods; Construction of modal models; Back transform from modal to physical models.	7
IV	**Machining dynamics and regenerative chatter vibrations in turning:** Forced vibration analysis during cutting, Tool and workpiece vibration analysis; Tooth passing frequency concepts, Frequency analysis of time domain cutting signals, Introduction to regenerative chatter; Wave generation; Phase shifts; Block diagram level analysis of machining dynamics, Introduction to delay differential equations Review of definitions of stability; Causes and types of stability, Review Tlusty's approach to stability diagrams; Construction of stability lobe diagrams for SDOF systems, Turning stability of 2 DOF systems and Chip thickness, force and displacement calculation.	9

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V	**Process machine interactions in milling:** Modelling of end milling dynamics, Stability diagrams with Tlusty's average tooth angle approach, Linearization of process; Discussions about the effect of milling mode and engagement, Stability diagrams with Fourier series approach, Linearization of process.	7
VI	**Design of passive and active machine tool foundations:** Overview of machine tool foundations, Definition and characteristics of passive foundations, Types of passive foundations (e.g., block-type, box-type, wall-type, framed-type), Design criteria for passive foundations, Definition and characteristics of active foundations, Types of active foundations (e.g., vibration isolation systems, active damping systems), Design criteria for active foundations, Case studies and examples	6
	Total Lecture Hours	**45**

Text Books:

1. Yusuf Altintas, *Manufacturing automation: Metal Cutting Mechanics, Machine Tool Vibration and CNC design*,2nd Edition, Cambridge Press,2012
2. Tony L Schmitz and Kevin Smith, *Machining Dynamics: Fundamentals, Application and Practices*,1st Edition, Springer Science and Business DEdia,2009
3. Konigsberg, Franz and Jiri Tlusty, *Machine Tool Structures*,1st Edition, Elsevier,2016

References:

1. Kai Cheng, *Machine Dynamics: Fundamental, Application and Practices*,1st Edition, Springer Science and Business DEdia,2008
2. George Tlusty, *Manufacturing Process and Equipment*,1st Edition, Pearson Education,1999
3. Weihong Zhang and Min Wan, *Milling simulation: Metal Milling Mechanics, Dynamics and Clamping Principles*,1st Edition, Wiley-ISTE,2016

Online Learning Resources:

1. MAT LAB https://www.mathworks.com/matlabcentral/fileexchange/
2. MIT Open Course Ware – Engineering Dynamics, Topics: Kinematics, force-momentum formulation, vibration of mechanical systems, Why it's useful: Builds the mathematical foundation for analyzing machine tool vibrations and dynamic stability.
3. Machine tool cutting tool design to mitigate vibration by Dr Mohit Law, IIT kanpur
   Link: https://www.youtube.com/watch?v=jecaZ77-EJQ

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Established: 1999

Course Information:								
Class, Semester	F. Y. M. Tech. - Semester II						**Category**	**PE**
Course Code, Course Title	**0DEPE523, Automatic Control**						**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**			
	3	1	-	-	4			
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**	
		40	20	40		-	-	

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Apply control system principles to model and analyze the dynamics of mechanical, electrical, thermal, and fluid systems using time-domain and frequency-domain methods.
CO2	Implement control system design techniques, including PID controllers, state-space methods, and compensators, to improve system performance and stability in mechanical systems.
CO3	Utilize advanced control methods, such as nonlinear, adaptive, and robust control, to address complex issues in mechanical systems like vibration control, robotics, and manufacturing processes.
CO4	Apply digital control techniques, including z-transforms and microcontroller-based systems, to design and implement controllers for real-world mechanical applications.
CO5	Use simulation tools like MATLAB/Simulink to model, simulate, and analyze mechanical systems, and implement control strategies to solve practical engineering problems.

Syllabus:

Module	Contents	Lecture Hours
I	**Fundamentals of Automatic Control:** Introduction to Automatic Control: Basic concepts, open-loop vs. closed-loop control systems, Mathematical Modelling: Transfer functions, state-space representation, block diagrams, and signal flow graphs, Dynamic Systems: modelling of electrical, mechanical, and electromechanical systems System Behaviour: Time-domain and frequency-domain characteristics, poles, zeros, and system stability.	7
II	**Time-Domain Analysis of Control Systems:** Transient Response Analysis: Response of first and second-order systems to standard inputs (step, impulse, ramp), sinusoidal step impulse response. Steady-State Errors: Error constants and system type. Performance Specifications: Rise time, settling time, peak time, overshoot. Applications: Time-domain analysis in mechanical systems (e.g., servomechanisms, suspension systems).	7
III	**Frequency-Domain Analysis of Control Systems:** Frequency Response Methods: Bode plots, Nyquist plots, and polar plots. Stability in Frequency Domain: Nyquist stability criterion and gain/phase margins. Resonance and Bandwidth: System performance evaluation using frequency-domain measures. Mechanical Applications: Frequency response analysis for vibration control and rotating machinery.	8
IV	**Control System Design Techniques:** Compensator Design: Lead, lag, and lead-lag compensators; design using Bode plots. PID Controller Design: Ziegler-Nichols tuning methods and implementation in mechanical systems. State-Space Representation: Concept, controllability, observability, and design of state-feedback controllers. Mechanical Applications: Control of mechanical systems such as robotic arms and vehicle dynamics.	8
V	**Advanced Control Techniques:** Nonlinear Systems: Characteristics of nonlinear systems, phase-plane analysis, and limit cycles. Lyapunov Stability: Direct and indirect methods for analyzing stability in nonlinear systems. Modern Control Methods: Adaptive control, robust control, and sliding mode control for mechanical systems. Applications in Mechanical Systems: Control of fluid-structure interaction, HVAC systems, and adaptive vibration control. Optimal Control using Dynamic Programming	8

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VI	**Digital Control Systems and Applications:** Introduction to Digital Control: Sampling, quantization, and z-transforms. Discrete-Time System Analysis: Stability and response of discrete systems. Implementation of Digital Controllers: Microcontroller-based and PLC-based control in mechanical systems. Case Studies in Mechanical Engineering using METLAB: Process control in manufacturing, CNC machine tools, and robotics.	7
	Total Lecture Hours	**45**

Text Books:

1. Gene F. , *Feedback Control of Dynamic Systems*,6th Edition, Pearson,2014
2. Ogata Katsuhiko, *Modern Control Engineering*,5th Edition, Prentice Hall,2010
3. Benjamin C. Kuo, *Automatic Control Systems*,8th Edition, Prentice Hall,2009
4. Norman S. Nise, *Control Systems Engineering*,7th Edition, Wiley,2011

References:

1. M.Gopal, *Control Systems: Principles and Design*,5th Edition, Wiley,2012
2. Ogata Katsuhiko, *Introduction to Control Engineering*,2nd Edition, Prentice Hall,1995
3. Wilson J. Rugh, *Linear System Theory and Design*,2nd Edition,1996

Online Learning Resources:

1.NPTEL Course on Automatic Control, by Anil Kumar, IIT Roorkee.
Link https://nptel.ac.in/courses/112107240
2.YouTube Video on Introduction to Automatic Control
Link: https://www.youtube.com/watch?v=2MRu9SQCU_g

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE524, Computational Fluid Dynamics**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the governing equations of fluid flow, methodology of grids generation and discretization, algorithms and turbulence modelling by considering different assumptions of fluid flow.
CO2	Apply various discretization methods to solve the fluid flow problems with accuracy.
CO3	Compute the fluid flow parameters or temperature by applying appropriate boundary conditions for different applications.
CO4	Evaluate the performance/fluid parameters and interpret the flow pattern for the given application by using CFD techniques.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction to Computational Fluid Dynamics & Principles of Conservation:** Introduction to Computational Fluid Dynamics, CFD Applications, Numerical vs. Analytical vs. Experimental, Modeling vs. Experimentation, typical problems, Summary Equations for Viscous Flow (the Navier-Stokes Equations) Equations for Inviscid Flow (the Euler Equations) Forms of the Governing Equations Particularly Suited for CFD, Working of Commercial CFD Software, Solution methodology-pre-processing, Solver, Post processing.	8
II	**Basics of discretization & Grid generation:** Basic concepts of discretization, Discretization techniques - Finite difference, Finite volume and Finite element method, Comparison of discretization methods, Boundary conditions and types, Structured and unstructured grid. Grid independence study, other grid types.	7
III	**Finite Difference Method:** Finite Difference Formulations: Introductory remarks, Taylor Series Expansions, Finite difference equations, Central Forward, Backward Numerical error, Explicit, Implicit, Semi-implicit (Crank- Nicholson method). Applications of direct, Iterative, Thomas algorithm, Gauss-Jacobi, Gauss-Seidal method. Alternate directional implicit, Applications. 1-D examples, 2-D examples.	7
IV	**Finite Volume Method:** Discretization of Unsteady, Diffusion, Advection and Source Terms, Advection Schemes: Central Difference Scheme, First Order Upwind Scheme, Second Order Upwind Scheme, QUICK scheme and Other Higher Order Schemes, FVM for 1D steady state Diffusion, FVM for 2 D Diffusion Finite Volume Solution of Unsteady Advection and Diffusion Problems. Steady 1-D Convection and Diffusion.	8
V	**Introduction to solution algorithms for pressure velocity coupling in steady flows & turbulence and multiphase modelling (Introductory treatment):** Introduction, staggered grid, introduction to SIMPLE, SIMLEC, SIMPLER, PISO algorithms, Modeling of multiphase problems, Level set methods, VOF method. Coupled LS+VOF	7
VI	**Introduction to Turbulence and its modelling:** Introduction to turbulence, Transition from laminar to turbulent flow; Effect of turbulence on time averaged Navier -Stokes equations; Characteristics of simple turbulent flows; Introduction to Turbulent Models like Mixing length Model, k-epsilon model, Reynolds's stress equation models, Algebraic stress equation models; Some recent Advances, introduction to LES, DNS.	8

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Total Lecture Hours	**45**

Text Books:

1. Gautam Biswas, *Computational Fluid Dynamics*,3rd Edition, Narosa Publishing House, New Delhi,2013
2. Babu V, *Fundamentals of Incompressible Fluid Flow*, 1st Edition, Anne Books Pvt Ltd. New Delhi, India,2010
3. Batchelor G. K., *Introduction to Fluid Dynamics*,2nd Edition, Cambridge University Press. New Delhi, India,1999
4. Raisinghania M.D, *Fluid Dynamics*,5th Edition, S Chand & Company, New Delhi,2003

References:

1. Anderson J. D. Jr., *Computational Fluid Mechanics the Basics with Applications*,6th Edition, McGraw Hill Education Pvt. Ltd.,2014
2. H. K. Versteeg and W. Malalasekera, *An introduction to Computational Fluid Dynamics; the finite volume method*,2nd Edition, Pearson Publication,2009
3. Suhas V. Patankar, *Numerical Heat Transfer Fluid Flow*,1st Edition, Taylor & Francis,2014
4. T. J. Chung, *Computational Fluid Dynamics*,3rd Edition, Cambridge University Press.,2014
5. Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu, *Computational Fluid Dynamics: A Practical Approach*, 2nd Edition, Butterworth – Heinemann, 2008

Online Learning Resources:

1. NPTEL Course on Computational Fluid Dynamics, by Prof. Suman Chakraborty, IIT Kharagpur Link:https://onlinecourses.nptel.ac.in/noc25me165/announcements?force=true
2. Open FOAM User Guide & Tutorials – Open FOAM Foundation Open-source CFD package with step-by-step tutorials.
3. NPTEL Course on Numerical Methods for Engineers By Prof. Niket Kaisare, IIT Madras Link:https://onlinecourses.nptel.ac.in/noc25_ge59/preview

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Department of Mechanical Engineering
Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE525, Design for Sustainability**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	1	-	-		4	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Explain the fundamentals of sustainability, life cycle cost (LCC), and their impact on product design
CO2	Apply principles of sustainable product design, considering environmental and technological sustainability.
CO3	Analyze and compare different life cycle cost models and select the most appropriate one for a given application.
CO4	Evaluate maintenance, repair, and disposal costs in product life cycle management for sustainable engineering solutions.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction:** History, definition, concept of product life cycle, life cycle cost (LCC), design for sustainability, product life cycle costing in changing industrial scenarios, traditional vs. LCC-based product selection, reliability, maintainability, availability, life cycle cost estimation.	7
II	**Product Design for Sustainability:** Sustainability and product design, types of sustainability, environmental sustainability, sustainment-dominated products, technology sustainment activities, technology obsolescence, technology insertion, technology monitoring, technology forecasting.	8
III	**Integrated Sustainable Life Cycle Design:** Concept of product life cycle design, **Design for X (DFX)**, design for manufacturing (DFM), design for assembly (DFA), design for reliability and maintainability (DFRM), design for serviceability (DFS), design for environment (DFE), design for product retirement (DFPR), life cycle assessment (LCA), integrated sustainable life cycle design.	7
IV	**Basics of Life Cycle Costing and Life Cycle Cost Models:** Cost issues in product life cycle design, theory of product life cycle costing, need for product life cycle costing, cost estimation approaches **(parametric, analogy-based, detailed, activity-based)**, life cycle costing applications. **Life Cycle Cost Models:** Classification, general and specific models, activity-based life cycle cost models, application of models to industrial products, life cycle costing economics, time value of money, present value of life cycle cost.	8
V	**Modelling Maintenance and Repair Costs:** Factors influencing maintenance cost, types of maintenance costs, preventive and corrective maintenance cost estimation **(manpower, materials, spare parts, repairs)**, maintenance cost estimation models, maintenance cost data collection, stochastic point processes for repairable systems, renewal process planning, minimal repair process modelling.	7
VI	**Modelling Product Disposal Costs:** Product end-of-life (EOL) strategies, factors affecting EOL strategies, product design for recyclability, recyclability and reuse compatibility analysis, material recycling, system recycling cost, design for disassembly, disassembly cost analysis, estimating product disposal costs. **Circular Economy:** Concept, principles and relevance to sustainable product design. **Recycling and Reuse Based Approach:** Design and planning considerations, economic and environmental impacts, case studies.	8

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	Activity-Based Life Cycle Costing (ABC): Principles, ABC applied to LCC, life cycle stages and cost drivers, LCC model development, estimation of LCC components, ABC applications in industrial product/machine LCC analysis.	
	Total Lecture Hours	**45**

Text Books:

1. W.J. Fabrycky, Benjamin S. Blanchard, Life-cycle Cost and Economic Analysis, Prentice Hall International Series in Industrial and Systems Engineering,1991
2. B. S. Dhillon, Life Cycle Costing: Techniques, Models, and Applications, Gordon and Breach Science Publishers,1989
3. Jan Emblemsvag, Life-Cycle Costing: using activity-based costing and Monte Carlo methods to manage future costs and risks, John Wiley and Sons,2000
4. B. S. Dhillon, Life Cycle Costing for Engineers, CRC Press, Taylor and Francis Group,2010
5. Alphonse J. Dell'Isola, Stephen J. Kirk, Life cycle costing for design professionals, McGraw-Hill, 1981
6. Guangbin Yang, Life Cycle Reliability Engineering, John Wiley and Sons,2007
7. Fabio Giudice, Guido La Rosa, Antonino Risitano, Product design for the environment: A Life Cycle Approach, CRC/Taylor & Francis,2006

References:

1. Krishna B. Misra, Handbook of Performability Engineering, Springer,2008
2. Sandborn, P., and Myers, J., Designing Engineering Systems for Sustainability, Springer,2008
3. Tracy Bhamra, Vicky Lofthouse, Design For Sustainability: A Practical Approach, Gower Publishing,2007

Online Learning Resources:

1. NPTEL course on System Design for Sustainability by Prof. Sharmistha Banerjee, IIT Guwahati
Link: https://onlinecourses.nptel.ac.in/noc25_de21/preview

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**PE**
Course Code, Course Title	**0DEPE526, Material Handling Equipment Design**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	1	-	-	4		

Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) : Upon successful completion of this course, the student will be able to

CO1	Explain the fundamental concepts or principles of material handling systems under various industrial applications to identify suitable equipment selection by ensuring efficiency, cost-effectiveness, and operational feasibility.
CO2	Apply design principles for hoists, cranes, and elevators by considering load requirements and industrial standards to develop safe and reliable lifting mechanisms that comply with operational and safety regulations.
CO3	Analyze the mechanical and structural aspects of material handling equipment's based on stability, load distribution, and motion constraints to recommend optimized design solutions ensuring functionality and durability.
CO4	Assess design of bucket elevators and load-lifting attachments under varying load conditions and handling requirements to optimize material flow and lifting performance by ensuring compliance with safety standards, function ability & durability.
CO5	Evaluate packaging and storage techniques by conducting tests on protective packaging and industrial storage systems to enhance material safety and logistics efficiency using modern automation solutions.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction to Material Handling Equipment's:** Overview - consideration in material handling system design, principles of material handling, Types of material handling equipment's-trolleys, industrial trucks, AGV, monorails and other rail guided vehicles, conveyors, cranes, hoists and elevators etc., Equipment selection and Applications	7
II	**Design of Hoists:** Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments - Design of arresting gear - Brakes: shoe, band and cone types.	8
III	**Design of Cranes:** Hand-propelled and electrically driven E.O.T overhead Traveling cranes; Traveling mechanisms of cantilever and monorail cranes; design considerations for structures of rotary cranes with fixed radius ; fixed post and overhead traveling cranes; Stability of stationary rotary and traveling rotary cranes	8
IV	**Design of bucket Elevator:** Introduction, Types of Bucket Elevator, loading & bucket arrangements, Design of Bucket Elevator- loading and bucket arrangements, Cage elevators, shaft way, guides, counterweights, hoisting machine, safety devices - Design of fork lift trucks.	8
V	**Design of load lifting attachments:** Load chains and types of ropes used in Material Handling System, Forged, Standard and Ramshorn Hooks, Crane Grabs and Clamps; Grab Buckets, Electromagnet, Design consideration for conveyor belts, Application of attachments	7
VI	**Design of Concrete Handling Equipment:** Overview of concrete properties and handling stages; types of handling equipment including mixers, conveyors, pumps, cranes and vibrators; Design parameters such as load analysis, capacity, power requirements and vibration resistance; performance evaluation, automation	7

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	integration and safety measures for efficient, reliable and quality concrete placement in construction projects.	
	Total Lecture Hours	**45**

Text Books:

1. N. Rudenko, Material Handling Equipments,3rd Edition, Peace Publishers,2012
2. James M. Apple, Material Handling System Design,8th Edition, John-Wiley and Sons Publication,2010
3. John R. Immer, Material Handling,8th Edition, Tata McGraw Hill,2004
4. James M. Apple, Mechanical Handling of Materials, Krieger Publishing,2nd Edition,2014
5. David E. Mulcahy, Handbook of Material Handling Systems,1st Edition,2007
6. Raymond A. Kulweic (Editor), Materials Handling Handbook,2nd Edition, Wiley,2009
7. Sharma, S.C., & Aggarwal, S.K, Construction Equipment and Management,1st Edition, Khanna Publishers,2019

References:

1. M .P. Nexandrn, Material Handling Equipment,1st Edition, MIR Publication,2004
2. A.Shapiro, Design of Hoisting and Lifting Equipment,1st Edition, ASME Press,2015
3. Shapiro & Shapiro, Crane Design Manual,4th Edition,ASME Press,2012
4. John A. White, Marvin J. Finch, Principles of Material Handling,1st Edition, McGraw Hill,2008
5. CEMA (Conveyor Equipment Mfrs), Bulk Material Handling by Conveyor Belts,6th Edition, CEMA Publications,2020
6. Peurifoy, Schexnayder, Shapira, Schmitt, and Cohen, Construction Planning, Equipment, and Methods,10th Edition,2023

Online Learning Resources:

1. NPTEL Course on Bulk Material Transport and Handling Systems, by Prof. Khanindra Pathak, IIT Kharagpur (via SWAYAM)
2. Link: https://onlinecourses.nptel.ac.in/noc22_mm20/preview
3. NPTEL Course on Industrial Automation and Control, by Prof. S. Mukhopadhyay, IIT Kharagpur Link: https://nptel.ac.in/courses/108105062
4. Coursera – Supply Chain Logistics & Material Handling (University of Minnesota) Link: https://www.coursera.org/learn/supply-chain-logistics S
5. WAYAM Course on Bulk Material Transport and Handling Systems Link: https://onlinecourses.swayam2.ac.in/aic20_sp15/preview
6. College-Industry Council on Material Handling Education (CICMHE) – Academic & Industry Learning Resources Link: https://www.mhi.org/cicmhe

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Department of Mechanical Engineering
Established: 1999

Course Information:

Class, Semester	FY. M. Tech. Semester – II					**Category**	**OE**
Course Code, Course Title	**0DEOE527, Optimization Techniques**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**		**Practical**	**Self-Study**		**Credits**
	3	-		-	2		3
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs): Upon successful completion of this course, the student will be able to:

CO1	Apply optimization and meta-heuristic techniques to engineering optimization problems.
CO2	Analyze the structure and learning of Artificial Neural Networks using perceptron's and backpropagation.
CO3	Apply fuzzy logic methods for modeling, reasoning, and control in engineering systems.
CO4	Evaluate the performance of Genetic Algorithms, Neural Networks, and Fuzzy Systems against conventional methods.
CO5	Analyze hybrid approaches such as Neuro-fuzzy and ANFIS for system optimization.
CO6	Create domain-specific AI-based soft computing solutions to complex engineering problems.

Syllabus:

Module	Contents	Lecture Hours
I	**FUNDAMENTALS OF SOFT COMPUTING TECHNIQUES:** Definition-Classification of optimization problems - Unconstrained and Constrained optimization - Optimality conditions - Introduction to intelligent systems - soft computing techniques – Conventional Computing versus Swarm Computing - Classification of meta-heuristic techniques - Single solution based and population-based algorithms – Exploitation and exploration in population-based algorithms - Properties of Swarm intelligent Systems	8
II	**ARTIFICIAL NEURAL NETWORKS:** Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and training the neural network. Multi – layer perceptron using Back propagation Algorithm (BPA)	8
III	**FUZZY LOGIC:** Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control (Mamdani and Sugeno) – Fuzzification, inferencing and defuzzification-Fuzzy knowledge and rule bases-Applications	7
IV	**GENETIC ALGORITHMS:** Basic concept of Genetic algorithms - Genetic Algorithm versus Conventional Optimization Techniques – Genetic representations and selection mechanisms; Genetic operators - different types of crossover and mutation operators- Optimization problems using GA.	7
V	**HYBRID CONTROL SCHEMES:** Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron -Optimization of membership function and rule base using Genetic Algorithm – Particle Swarm Optimization	8
VI	**MECHANICAL:** Energy Demand Prediction in HVAC Systems, Fluid Flow in Piping Systems, Manufacturing Process Optimization, Engine Speed & Load Control, Multi-Machine Coordination, Vibration Control in Machines, Thermal Management	7
	Total Lecture Hours	**45**

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Text Books:
1. Laurene V. Fausett, *Fundamentals of Neural Networks: Architectures, Algorithms and Applications*, 1st Edition, Pearson Education, 1993.
2. Timothy J. Ross, *Fuzzy Logic with Engineering Applications*, 3rd Edition, Wiley India, 2010.
3. H. J. Zimmermann, *Fuzzy Set Theory and Its Applications*, 4th Edition, Springer International, 2001.
4. David E. Goldberg, *Genetic Algorithms in Search, Optimization, and Machine Learning*, 1st Edition, Pearson Education, 1989.
5. S. N. Sivanandam & S. N. Deepa, *Principles of Soft Computing*, 3rd Edition, Wiley India, 2018.
References:
1. S. Rajasekaran & G. A. Vijayalakshmi Pai, *Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications*, 1st Edition, PHI Learning Pvt. Ltd., 2003.
2. Robert J. Schalkoff, *Artificial Neural Networks*, 1st Edition, Tata McGraw Hill, 1997.
3. N. P. Padhy, *Artificial Intelligence and Intelligent Systems*, 1st Edition, Oxford University Press, 2005.
4. D. P. Kothari & J. S. Dhillon, *Power System Optimization*, 2nd Edition, PHI Learning Pvt. Ltd., 2010.
Online Learning Resources
1. Deep Learning Specialization by Andrew Ng (Coursera) **https://www.coursera.org/specializations/deep-learning**
2. Fuzzy Sets, Logic and Systems & Applications (NPTEL) **https://onlinecourses.nptel.ac.in/noc22_ee21/preview**
3. Genetic Algorithms (NPTEL) **https://nptel.ac.in/courses/112105235**
4. Soft Computing Techniques (NPTEL) **https://onlinecourses.nptel.ac.in/noc25_ma54/preview**
5. Machine Learning Specialization (Coursera) **https://www.coursera.org/specializations/machine-learning**

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**OE**
Course Code, Course Title	**0DEOE528, Operations Research**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	3	-	-	-	3		
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Formulate Linear Programming problems for various OR models.
CO2	Solve various types of problems related Assignment and Transportation models of Operational Management.
CO3	Solve various types of problems of decision, Replacement and Queuing theory models of Operational Management.
CO4	Construct network diagrams and determine critical path, floats for deterministic and PERT networks.
CO5	Explain the methods of Data collection and Solve the problems of central tendency of measures.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction to OR and Linear Programming Problems Introduction:** History and development of OR, Applications, modeling in OR, OR models and their applications. Linear Programming Problems: Formulation of problem, Graphical solution,	8
II	**Assignment Model and Transportation Model Assignment Model:** Mathematical statement, Methods to solve balanced and unbalanced assignment problems, Maximization problems, Assignment with restrictions, Traveling salesman problem. Transportation Model: Mathematical formulation, methods to obtain initial basic feasible solution (IBFS), NWCR, Least Cost and VAM, Conditions for testing optimality, MODI method for testing optimality solution of balanced and unbalanced problems,	7
III	**Decision Theory:** Introduction, payoff table, Opportunity loss or regret table, Decisions under uncertainty, Laplace criterion, Maximin or Minimax principle, Maximax or Minimin principle, Hurwicz principle, Decisions under risk–maximum likelihood criteria, Expectation principle, Expected opportunity loss, decision trees.	7
IV	**Project Management:** Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Replacement theory: Computation **Sequencing**: Sequencing of n jobs on two machines, n jobs on three machines, n job m machines	8
V	**Replacement theory** Need, Replacement of items whose maintenance cost increases with time (with and without considering time value of money), Replacement of items that fail suddenly. **Queueing Systems:** General concepts of a queueing system, measures of performance, arrival and service processes, single and multiple server models, channels in parallel and in series with limited and unlimited queues, little's formula, Queues with finite waiting room, Queues with impatient customer(Balking and reneging)	6
VI	**Data Analysis:** Data Collection: sources and methods of data collection, questionnaire design, sampling sample size, sampling distribution, methods of sampling, sampling errors. Data Analysis: Pictorial Representation-Cross tabulation, Bar Chart, Pei Chart, Histogram, Ogive etc. Numerical calculation-Measures of Central Tendency-mean, median, mode, quartiles, deciles and percentiles. Measures of Dispersions- range, mean deviation, quartile deviation and standard deviation. Correlation, Regression.	8

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Total Lecture Hours	**45**

Text Books:

1. J.P. Bose, S. Talukdar, Business Management,3rd Edition , New Central Agencies (P) Ltd., Delhi, 2010
2. J.K. Sharma,V, Operation Research, 8th Edition, McMillan India Publication, Delhi,2011
3. Manohar Mahajan, Operations Research,, 8th Edition,Dhanapat Rai And Sons, Delhi,2009
4. S.N.Chary, Production and operation management, 5th Edition, Tata McGraw hill Delhi,2015

References:

1. Hamdy A. Taha, Introduction to Operation Research,8th Edition,Prentice Hall India Publication, New Delhi,2011
2. D.S. Hira & P.K. Gupta, Operations Research, 5th Edition,S. Chand & Co., New Delhi,2011
3. M.T.Telsang, Industrial Engineering and Production Management,4th Edition,S. Chand & Co., New Delhi,2013
4. R.B.Khanna, Production and Operation Management, 2nd Edition, PHI,2015

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Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**OE**
Course Code, Course Title	**0DEOE529, Composite Materials**					**Type**	**T1**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**	
	3	-	-	-		3	
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		40	20	40		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Differentiate composites with respect to various isotropic materials.
CO2	Understand different processing techniques used to manufacture polymer composites.
CO3	Solve for stresses and strains in the lamina.
CO4	Solve for stresses and strains and analyze the laminate using various failure theories
CO5	Design and analyze laminated structures.

Syllabus:

Module	Contents	Lecture Hours
I	**Introduction:** Introduction to Composite Materials; Classification of composites, Fibrous Composites, FRP constituents, Reinforcement types, Types of materials (Isotropic, Orthotropic, Anisotropic;	8
II	**Ply Stiffness Analysis:** Generalized Hooke's Law-Elastic constants for anisotropic, Orthotropic and isotropic materials. Specially orthotropic ply, generally orthotropic ply, Transformation of elastic constants	7
III	**Ply strength analysis:** Isotropic ply, orthotropic ply, failure criteria, sign of shear stresses, choice of failure criterion typical strength properties	7
IV	**Laminate Stiffness analysis:** Layered laminate, beam constitutive equation, laminate constitutive equation, equivalent elastic constants, stiffness formulation procedure, laminate configuration types, Symmetric SOPL-isotropic plies, specially orthotropic plies, generally orthotropic plies. Symmetric MOPL-isotropic plies, specially orthotropic plies, generally orthotropic plies.	8
V	**Laminate Strength Analysis:** First-Ply-Failure (FRF) Procedure, FPF: symmetric laminate-membrane load, FPF: symmetric laminate- bending load. Last- Ply-Failure (FRF) Procedure, LPF: complete ply failure-membrane load, partial ply failure-membrane load, complete ply failure-bending load, estimated laminate strength	8
VI	**Thin-Walled Composite Sections:** Assumptions and axes systems, axial force, symmetrical bending, unsymmetrical bending, shear forces.	7
	Total Lecture Hours	45

Text Books:

1. Datoo M H, *Mechanics of Fibrous Composites*, Springer, 1991
2. B.D. Agarwal and L.J. Broutman, *Analysis and Performance of Fibre Composite*, John Wiley & Sons, Inc., 1997
3. Karl T Herakovich, *Mechanics of Fibrous Composites*, Wiley, 1998

References:

1. RM Christensen, *Mechanics of Composite Materials*,2nd Edition, Krieger Publishing Company, 2000
2. J.M. Hodgkinson, *Mechanical Testing of Advanced Fibre Composites*,3rd Edition, Woodhead Publishing Limited, 2000

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Online Learning Resources:
1. NPTEL Course on Mechanics of Composite Materials and Structures by Prof. Mohammed Rabius Sunny, IIT Kharakpur Link; https://onlinecourses.nptel.ac.in/noc25_ae33/preview
2. Online Course on Mechanics of Materials I: Fundamentals of Stress & Strain and Axial Loading , by Dr, Wayne Whiteman, Georgia Institute of Technology, Link: https://www.coursera.org/learn/mechanics-1

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Department of Mechanical Engineering

Established: 1999

Course Information:

Class, Semester	F. Y. M. Tech. - Semester II					**Category**	**MA**
Course Code, Course Title	**0DEMA530, Pedagogy Studies**					**Type**	**T2**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**	**Credits**		
	2	-	-	-	2		
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**
		-	50	-		-	-

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Apply pedagogical principles and outcome-based education frameworks to enhance engineering instruction.
CO2	Implement learner-centered strategies to address the diverse learning needs of engineering students.
CO3	Design and deliver effective instructional methods to improve engagement and knowledge transfer in technical education.
CO4	Integrate digital tools and emerging technologies to enrich the teaching-learning process.
CO5	Develop an appropriate assessment technique to evaluate and improve student learning outcomes and foster industry collaboration for continuous improvement in engineering education.

Syllabus:

Module	Contents	Lecture Hours
I	**Foundations of Pedagogy in Engineering Education:** Introduction of Pedagogy- Importance of Pedagogy in Engineering- Role of a Teacher in Technical Education- Outcome-Based Education (OBE) in Engineering - Bloom's Taxonomy for Engineering Course Design-Importance of Program Outcomes (POs), Course Outcomes (COs), and Graduate Attributes (GAs)	5
II	**Learner-Centered Approaches in Engineering Education:** Role of Engineering Educators in the 21st Century-Student Mentoring and Counseling Essentials-Creating Inclusive Classrooms: Activity oriented model, Addressing Diversity, Gender Sensitivity, Cognitive development and Special Needs-Generation Z and Millennial Learners: Expectations & Challenges	5
III	**Instructional Design and Delivery of content:** Curriculum Development and Course Planning- Instructional Design- Effective Delivery Strategies: Project based learning, Problem based learning, and Participative based learning. Teaching Strategies: flipped classroom approach and think pair share based approach.	5
IV	**Technology Integration and Digital Tools in Engineering Education:** E-Learning Platforms (Moodle, Google Classroom, SWAYAM, NPTEL, MOOCs)- Virtual Labs and MATLAB Simulators in Engineering- Educational Technology Tools-Creating Engaging Multimedia Content (Videos, Animations, Interactive Content)	5
V	**Assessment, Evaluation, and Feedback in Engineering:** Designing Effective Formative Assessments - Experiential learning - Continuous Internal Assessment and Summative Assessment Strategies- Developing Rubrics for Courses and Lab Assessments -Academic Integrity: Plagiarism, Ethics, and Fair Assessment	5
VI	**Professional Development, Industry Collaboration in Engineering Education:** Soft Skills for Educators: Communication, Emotional Intelligence, Classroom Management, portfolio Management- Time and Stress Management for Faculty - Entrepreneurship and Innovation eco system in Classrooms	5
	Total Lecture Hours	**30**

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Text Books:
1. Greg Light, Susanna Calkins, Roy Cox, *Learning and Teaching in Higher Education: The Reflective Professional*, 2nd Edition, SAGE Publications, 2009. 2. Milo D. Larson, Chin-Chung Tsai, *Engineering Education: Future Trends and Advances*, 1st Edition, Nova Science Publishers, 2019.
References:
1. Stephen D. Brookfield, *The Skillful Teacher: On Technique, Trust, and Responsiveness*, 3rd Edition, Jossey-Bass, 2015. 2. Peter L. Schneller, Melinda M. Wilde, *Curriculum Development in Higher Education: Faculty-Driven Processes and Practices*, 1st Edition, Routledge, 2012. 3. John Biggs, Catherine Tang, *Teaching for Quality Learning at University*, 4th Edition, Open University Press, 2011. 4. Phillip C. Wankat, Frank S. Oreovicz, *Teaching Engineering*, 2nd Edition, Purdue University Press, 2015. Richard M. Felder, Rebecca Brent, *Teaching and Learning STEM: A Practical Guide*, 1st Edition, Jossey-Bass, 2016

Member Secretary-BoS Chairman -BoS Member Secretary-AC Chairman-AC

Annasaheb Dange College of Engineering and Technology
Ashta - 416301, Dist. : Sangli, Maharashtra
(An Empowered Autonomous Institute)
Department of Mechanical Engineering

Established: 1999

Course Information:								
Class, Semester	F. Y. M. Tech. - Semester II						**Category**	**VS**
Course Code, Course Title	**0DEVS531, Seminar**						**Type**	**L2**
Teaching Scheme (per week)	**Lecture**	**Tutorial**	**Practical**	**Self-Study**		**Credits**		
	-	-	4	-		2		
Examination Scheme (Marks)	**Theory**	**MSE**	**TA**	**ESE**	**Practical**	**CIA**	**ESE**	
		-	-	-		50	-	

Course Outcomes (COs) :
Upon successful completion of this course, the student will be able to

CO1	Identify and articulate a relevant research problem in the chosen specialization.
CO2	Conduct a comprehensive literature survey using reputed journals, conferences, and databases.
CO3	Apply critical thinking to compare and evaluate existing solutions.
CO4	Prepare a well-structured technical report using appropriate citation styles.
CO5	Deliver an effective oral presentation with clarity, confidence, and audience engagement.

Syllabus:

Module	Contents	Lecture Hours
Course Details:	**Seminar-** Should be based on the literature survey on any topic relevant to Mechanical Design Engineering (should be helpful for selecting a probable title of the dissertation). Each student has to prepare a write up of about 25-30 pages of "A4" size sheets and submit it in IEEE format in duplicate as the term work. The student has to deliver a seminar talk in front of the faculty of the department and his classmates. The concerned faculty should assess the students based on the quality of work carried out, preparation and understanding of the candidates. Some marks should be reserved for the attendance of a student in the seminars of other students	-

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