

Shree Warana Vibhag Shikshan Mandal's

**WARANA UNIVERSITY,  
WARANANAGAR**

(A State Public University established under Section 3 (6) of MPUA, 2016)

॥ विद्या सर्वस्य भूषणम् ॥



Warana University

Established:2025

**Structure & Syllabus For  
First Year of M. Tech. Design Engineering  
Semester- I and II  
Department of Mechanical Engineering**

**UNDER**

**Faculty of Science & Technology**

(As Per National Education Policy – 2020)

With Effect from Academic Year 2025-26 Onwards



Shree Warana Vibhag Shikshan Mandal's  
**TATYASAHEB KORE INSTITUTE OF ENGINEERING AND TECHNOLOGY**  
(AUTONOMOUS), WARANANAGAR, KOLHAPUR



Lead Institute of



**WARANA UNIVERSITY, WARANANAGAR**  
(A State Public University)



# Department of Mechanical Engineering

(Design Engineering)

## Post Graduate (P.G.)

Under

**Faculty of Science & Technology**

From Academic Year 2025-26

**M. Tech. in Mechanical (Design – Engineering)**

Structure and Syllabus under Autonomy as per NEP Policy 2020

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## Preface

The National Education Policy (NEP) 2020 has brought transformative reforms in India's higher education system, with a strong emphasis on multidisciplinary learning, innovation, skill development, and industry-oriented education. In line with these progressive reforms, Tatyasaheb Kore Institute of Engineering & Technology (TKIET), Warana University, Warananagar, are committed to implementing NEP 2020 in its true spirit to nurture competent, ethical, and socially responsible engineers.

The Department of Mechanical Engineering is pleased to present the syllabus for the Design Engineering, meticulously structured in accordance with the guidelines of NEP 2020 and contemporary industry requirements. This programme is designed to strengthen students' fundamental understanding of engineering design principles, product development, material selection, manufacturing considerations, and modern computer-aided design and analysis tools. Special focus is given to creativity, critical thinking, sustainability, and innovation, enabling students to convert conceptual ideas into practical and feasible engineering solutions.

This syllabus provides detailed information regarding course structure, credit system, learning outcomes, evaluation schemes, and academic guidelines to ensure effective implementation. The Department sincerely acknowledges the valuable contributions of the Board of Studies members, faculty experts, and industry professionals who have played a vital role in framing this curriculum.

We are confident that this Design Engineering Programme, developed in accordance with NEP 2020, will empower students with strong technical competence, innovative thinking, and lifelong learning abilities. We look forward to nurturing future-ready mechanical engineers who will contribute meaningfully to industry, society, and national development.

## Program Outcomes

Program Outcomes (POs) are clear, measurable statements that describe what students are expected to know, understand, and be able to do by the time they complete an academic program. They define the competencies, skills, and professional abilities that graduates should possess at the end of the program. In India, POs for Engineering Programs are formally prescribed and monitored by the National Board of Accreditation (NBA). NBA has defined the following three POs for a graduate of PG Engineering Program:

**PO1:** An ability to independently carry out research /investigation and development work to solve practical problems.

**PO2:** An ability to write and present a substantial technical Report/document.

**PO3:** Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

## **Duration**

- The full time M. Tech Program is a **2 years post graduate program**.
- The program is divided into **4 semesters**.

## **Eligibility**

1. The Candidate should be an Indian National.
2. Passed Bachelor's Degree in the relevant field of Engineering & Technology from AICTE or Central or State Government approved institutions or equivalent, with at least 50% marks (at least 45% marks in case of candidates of Backward Class categories, EWS and PWD).
3. Obtained Qualified score or non-qualified score in GATE conducted by the IIT for the current academic year.

OR

3. For sponsored candidates (Proforma P and Q), a minimum of two years of full-time work experience in a registered firm/ company/ industry/ educational and/ or research institute/ any Government Department or Government Autonomous Organization in the relevant field in which admission is being required..

## **Medium of Instruction**

- The medium of instruction, examinations, assignments, and project reports is English.

## Abbreviations

<b>Acronym</b>	<b>Full Form</b>
ISE	In-Semester Examination
ISE -I	In-Semester Examination I
ISE-II	In-Semester Examination II
ESE	End Semester Examination
ISA	In Semester Assessment
POE	Practical Oral Examination
TH	Theory Lecture
Tut	Tutorial
PH	Practical Hours
P	Practical
O	Oral
TW	Term Work
CH	Contact Hours
C	Credit
PCC	Professional Core Course
PE	Program Elective
OEC	Open Elective Course
LC	Laboratory Course
MC	Mandatory Course
SW	Seminar work
II	Industrial Internship
PC	Dissertation
SLC/AC	Self Learning Course/Audit course

## Examination & Evaluation Pattern

Evaluation tools used for the evaluation of a student for each course is as follows:

For Theory Courses	In-Semester Examination (ISE) And End Semester Examination (ESE)
For Lab / Tutorial Courses	In-Semester Assessment (ISA) And / Or Practical and Oral Examination (POE)

Refer course structure for specific evaluation tools used for each course.

### In-Semester Examination (ISE)

The In-Semester Examination (ISE) will be conducted at the departmental level. There will be two tests in each semester for every theory course: ISE-I and ISE-II.

- Each test will be of 40 marks.
- The duration of each test will be 1 hour and 30 minutes.

The total ISE marks will be calculated as the average of ISE-I and ISE-II. These rules may be modified from time to time as per the guidelines of the concerned regulatory authorities.

- ISE-I will cover Unit I and Unit II.
- ISE-II will cover Unit III and Unit IV.

#### ▪ Minimum Passing Criteria

Students must score a minimum of 40% marks in the ISE. If a student fails to secure the minimum required marks, he/she must appear for a Make-up Examination.

The Make-up Examination will be conducted in the same semester for:

- Students who fail to secure minimum passing marks.
- Students who were absent due to valid reasons such as medical issues, natural calamities, or participation in NSS, NCC, or similar activities (subject to verification of absence and recommendation from the Head of Department).

▪ **Special Provision**

If a failed student appears for three tests (including the Make-up test) and scores more than 16 marks when calculating the average of the best two out of the three tests, the student will be awarded the minimum passing marks of 16 only.

For students absent with valid reasons:

- If absent in one test, the average of the attempted test and the Make-up test will be considered.
- If absent in two tests, the decision will be taken after reviewing the reasons and based on the recommendation of the Head of Department.

**End Semester Examination (ESE):**

The End Semester Examination (ESE) will be conducted for 60 marks and will be based on the entire syllabus. The duration of each examination will be 2 hours.

**Weightage of Units**

The weightage of units in the ESE question paper will be as follows:

- a) Units that are not covered in ISE-I or ISE-II will carry 30% weightage each.
- b) Units that are covered in ISE-I and ISE-II will carry 10% weightage each.

**Backlog Examination**

Students who fail in the End Semester Examination (ESE) of either the odd or even semester within an academic year will be allowed to appear for the Backlog Examination, which will be conducted along with the regular ESE of the respective semester.

▪ **Re-Examination of ESE**

A Re-Examination (Make-up Examination) for all courses (UG and PG), including both theory and laboratory courses, will be conducted once a year before the commencement of the odd semester of the next academic year.

- A one-grade penalty will be applied to students appearing for the Make-up/Re-Examination.
  - However, no grade penalty will be applied if a student secures a 'P' grade in the Make-up/Re-Examination.
  - Grace marks will not be awarded for the Make-up/Re-Examination.
  - Exception: Grace marks may be considered if the student is appearing for the ESE for the first time.
- **Eligibility Criteria for ESE**

To be eligible for the End Semester Examination (ESE), a student must:

- Secure at least 40% marks in ISE and ISA of the concerned course.

- Fulfil the attendance requirements as per the norms of Warana University, Warananagar.

If a student does not meet these requirements, he/she will not be eligible to appear for the ESE.

Nature of Question Paper for ESE

Q. No.		Mark s	BL	C O
<b>1</b>	<b>Attempt the following.</b>	<b>24</b>		
	<b>a</b> <b>Unit -1</b>		II	1
	<b>b</b> <b>Unit -2</b>		III	2
	<b>c</b> <b>Unit -3</b>		IV	1
	<b>d</b> <b>Unit -4</b>		I	1
<b>2</b>	<b>Attempt any Two of the following.</b>	<b>18</b>		
	<b>a</b> <b>Unit -5</b>		VI	2
	<b>b</b> <b>Unit -5</b>		II	3
	<b>c</b> <b>Unit -5</b>		IV	3
<b>3</b>	<b>Attempt any Two of the following.</b>	<b>18</b>		
	<b>a</b> <b>Unit -6</b>		IV	4
	<b>b</b> <b>Unit -6</b>		III	4
	<b>c</b> <b>Unit -6</b>		III	4

### **In Semester Assessment (ISA):**

ISA for laboratory courses will be conducted as a continuous assessment throughout the semester. The assessment will be based on the following:

1. Performance in laboratory work.
2. Submission of experiments in the form of a properly maintained journal or report.
3. Timely completion of assigned experiments.
4. Attendance in laboratory sessions.
5. Understanding of the experiments conducted, evaluated through methods such as quizzes, oral examinations, case studies, field work, surveys, open-book tests, model preparation, programming, projects, or any other criteria specified by the course teacher.

### **Practical Oral Examination (POE):**

POE for laboratory courses will be conducted immediately after the end of the semester. The duration of the practical examination will be as specified in the curriculum structure. The POE will be conducted jointly by an Internal Examiner and an External Examiner.

The examination may be conducted in any one of the following ways:

**1. Oral Examination Only**

Both the Internal and External Examiners will ask questions based on the practical content of the course to assess the student's practical knowledge.

**2. Practical Examination Only**

Students will be required to perform a given experiment, complete a workshop task, prepare a drawing, or develop a computer program, as applicable. In this case, the student's performance will be evaluated by the External Examiner only.

**3. Practical and Oral Examination**

Students will first perform a given practical task. This will be followed by an oral examination (viva voce) based on the practical content of the course. The student's performance will be evaluated jointly by both the Internal and External Examiners.

## Grading System

The University follows a **10-Point Grading System** to evaluate student performance.

- **Conversion of Marks into Grades**

In every semester, the marks you get in each subject (out of 100) are converted into **grade points** as per the table below. You need at least **40% marks** to pass a subject.

Marks Obtained (Out of 100)	Grade Point	Letter Grade	Meaning
Absent	0	AB	Absent
0 – 39	0	F	Fail
40 – 44	4	P	Pass
45 – 49	5	C	Average
50 – 59	6	B	Above Average
60 – 69	7	B+	Good
70 – 79	8	A	Very Good
80 – 89	9	A+	Excellent
90 – 100	10	O	Outstanding

**Note:**

1. If decimal marks are 0.5 or more, they will be rounded off to the next higher number. (Example: 59.5 will become 60)
2. For courses of 50 marks or 200 marks, marks will be converted proportionally to 100 marks before assigning grade points.

- **Calculation of Semester Grade Point Average (SGPA)**

SGPA is calculated at the end of each semester. It shows your average performance in one semester.

$$SGPA = \frac{\sum(\text{Credit} \times \text{Grade Point}) \text{ for each course of a Semester}}{\sum(\text{Credits}) \text{ for a Semester}}$$

- **Calculation of Cumulative Grade Point Average (CGPA)**

CGPA is calculated after completing multiple semesters. CGPA reflects the overall academic performance of the student in the program.

*CGPA*

$$= \frac{\sum(\text{Total Credits of a Semester} \times SGPA \text{ of Respective Semester}) \text{ of all semesters}}{\sum(\text{Course Credits}) \text{ of all Semesters}}$$

**Note:** The SGPA & CGPA shall be rounded off to 2 decimal points.



**First Year M. Tech. Design Engineering**

**Curriculum Structure & Evaluation Scheme for Semester-I**

Course Category	Course Code	Course Title	Teaching and Credit Scheme					Examination and Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
PCC	2501PMD EPCC101	Mathematical Modeling and Design Optimization	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
	2501PMD EPCC101T	Mathematical Modeling and Design Optimization Tutorial	-	1	-	1	1	ISA	25	10	10
								2501PMD EPCC102	Solid Mechanics	3	-
ISE	40	16									
2501PMD EPCC102T	Solid Mechanics (Tutorial)	-	1	-	1	1	ISA	25	10	10	
PE	2501PMD EPE103X	Program Elective-I	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
	2501PMD EPE104X	Program Elective-II	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
	2501PMD EPE105X	Program Elective-III	3	-	-	3	3	ESE	60	24	40
								ISE	40	16	
LC	2501PMD ELC106P	Design Engineering Lab	-	-	4	2	4	POE	25	10	20
								ISA	25	10	
SW	2501PMD ESW107T	Seminar-I	-	-	2	1	2	ISA	50	20	20
<b>Total</b>			<b>15</b>	<b>2</b>	<b>6</b>	<b>20</b>	<b>23</b>		<b>650</b>	<b>260</b>	<b>260</b>

**Note :** 'X' indicates the sequence number of PE/OE offered by the respective department.



**First Year M. Tech. Design Engineering**

**List of Program Electives for Semester-I**

	<b>Course Code</b>	<b>Course Title</b>
<b>Program Elective-I</b>	2501PMDEPE1031	Process Equipment Design
	2501PMDEPE1032	Material Handling Equipment Design
	2501PMDEPE1033	Product Design and Development
<b>Program Elective-II</b>	2501PMDEPE1041	Robotics
	2501PMDEPE1042	Machine Tool Design
	2501PMDEPE1043	Advanced Design Engineering
<b>Program Elective-III</b>	2501PMDEPE1051	Electric Vehicle
	2501PMDEPE1052	Advanced Finite Element Analysis
	2501PMDEPE1053	Reverse Engineering



**First Year M. Tech. Design Engineering**

**Curriculum Structure & Evaluation Scheme for Semester-II**

Course Category	Course Code	Course Title	Teaching and Credit Scheme					Examination and Evaluation Scheme			
			L	T	P	C	CH	Component	Marks	Min for Passing	
PCC	2501PMDEPC C201	Vibration Engineering	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
	2501PMDEPC C201T	Vibration Engineering (Tutorial)	--	1	--	1	1	ISA	25	10	10
2501PMDEPC C202	Smart Materials and Structure	3	--	--	3	3	ESE	60	24	40	
							ISE	40	16		
2501PMDEPC C202T	Smart Materials and Structure (Tutorial)	--	1	--	1	1	ISA	25	10	10	
PE	2501PMDEPE 203X	Program Elective-IV	3		--	3	3	ESE	60	24	40
								ISE	40	16	
	2501PMDEPE 204X	Program Elective-V	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
OE	2501PMDEO EC205X	Open Elective Course	3	--	--	3	3	ESE	60	24	40
								ISE	40	16	
LC	2501PMDELC 206	Computer Aided Analysis Lab	--	--	2	1	2	ISA	25	10	10
SW	2501PMDES W207	Seminar-II	--	--	2	1	2	ISA	50	20	20
CV	2501PMDEC V208P	Comprehensive Viva	--	--	2	1	2	OE	25	10	10
<b>Total</b>			<b>15</b>	<b>2</b>	<b>6</b>	<b>20</b>	<b>23</b>	<b>--</b>	<b>650</b>	<b>260</b>	<b>260</b>

**Note:** 'X' indicates the sequence number of Program Elective (PE) offered by Computer Science and Engineering Program. Students should opt for the Open Elective (OE) course from other departments. The list of OE courses offered by other departments is available in the structure. Although the OE course code is defined by the respective program in the structure, the actual opted OE course will appear on the mark card.



Estd. 1983

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### First Year M. Tech. Design Engineering

## List of Program Electives for Semester-II

	Course Code	Course Title
<b>Program Elective-IV</b>	2501PMDEPE2031	Experimental Stress Analysis
	2501PMDEPE2032	Design for sustainability and life cycle cost
	2501PMDEPE2033	Tribology
<b>Program Elective-V</b>	2501PMDEPE2041	Analysis and synthesis of Mechanisms
	2501PMDEPE2042	Vehicle Dynamics
	2501PMDEPE2043	Reliability Engineering



Estd. 1983



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**First Year M. Tech. Design Engineering****List of Open Electives Offered by All Programs**

Sr. No.	OE Offered by Program	Course Code	Open Elective Course
1	Chemical Engineering	2501PCHEOE2051	Project Management
2		2501PCHEOE2052	Operations Research
3		2501PCHEOE2053	Energy Technology
4	Electronics & Telecommunication Engineering	2501PETCOE2051	Advanced Operating Systems
5		2501PETCOE2052	Cyber Security
6		2501PETCOE2053	Artificial Intelligence and Machine Learning
7	Construction Management (Civil Engineering)	2501PCCMOE2051	Water Power Engineering
8		2501PCCMOE2052	Waste to Energy
9		2501PCCMOE2053	Contracts & Tenders
10	Mechanical Design (Mechanical Engineering)	2501PMDEOE2051	Cryogenics
11		2501PMDEOE2052	Design for Manufacture & Assembly
12		2501PMDEOE2053	Enterprise Resource Planning
13	Structural Engineering (Civil Engineering)	2501PCSTOE2051	Cost Management of Engineering Projects
14		2501PCSTOE2052	Optimization Techniques in Civil Engineering
15		2501PCSTOE2053	Industrial Safety
16	Computer Science and Engineering	2501PCSEOE2051	Ethical AI & Explainability
17		2501PCSEOE2052	Computer Vision
18		2501PCSEOE2053	High Performance Computing for Multidisciplinary Research

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPCCMDE101 Course Name: Mathematical Modeling and Design Optimization</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To understand the mathematical modeling and simulation techniques.
2	To learn the different Optimization techniques.
3	To practice the Classical Optimization technique, Single variable optimization technique & Multi-variable optimization technique.
4	To realize Taguchi Method.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Understand the variety of different types of models and simulations and the different ways in which they are used.
CO2	To understand the optimization process.
CO3	Use of different modeling and simulation techniques for the optimization process.
CO4	Understand Taguchi method for experimentation.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Research Modeling Simulation:</b> The Reality, the experiment and the model, Concept of modeling, Models as Approximations, Types of Modeling, Need and Classification of mathematical modeling, Use of Analogy, Data consideration and Testing of Models, Modeling of dynamic systems with differential equations.	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Simulation:</b> simulation of data in the form of mathematical equations, Linear-Non-linear equations, determining the Unknowns of Equations using Least Square Criterion, Process of Simulation, Steps and Features of Simulation Experiments and their Validation	<b>7 Hrs</b>

<b>Unit 3</b>	<b>Optimization Techniques: Classical Optimization Techniques:</b> Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method and Kuhn-Tucker Conditions.	<b>6 Hrs</b>
<b>Unit 4</b>	<b>Single-variable Optimization Techniques:</b> Linear and Non-Linear behavior, Unrestricted Search, Solution using Graphical Method and Numerical Methods, Interval-halving Method, Golden-section Method, Newton Method, Secant Method	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Multi-variable Optimization Techniques:</b> , Non-linear Equations, Steepest Descent Method, Conjugate Gradient Method, Davidson- Fletcher-Powell Method	<b>6 Hrs</b>
<b>Unit 6</b>	<b>Taguchi Method:</b> Introduction, Loss Function and Signal –to-noise ratios, Control Factors and Noise Factors, Orthogonal Design, Design of Experiments, steps in carrying out experiment, analysis of variances etc.	<b>7 Hrs</b>

### **Learning Resources:**

#### **Text Books**

1	Trochim, William M.K. (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN :81-7722-372-0
2	Montgomery, Douglas C., &Tunger, George C. (2007). 3/e, Applied Statistics & Probability for Engineers, (Wiley India).

#### **Reference Books**

1	Ross P.J., —Taguchi Techniques for Quality Engineering, TMH,2005.
2	Jeff Wu, —Experiments: Planning, Analysis and Parameter Design, John Wiley,2000.
3	Fox R.L., —Optimization Methods for Engineering Design, Addison Wesley,1971

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPCCMDE101T Course Name: Mathematical Modeling and Design Optimization Tutorial</b>		
Teaching Scheme	Credit	Evaluation Scheme
Tutorial: 01 Hours/Week	1	ISA: 25 Marks ESE: 00 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To understand the mathematical modeling and simulation techniques.
2	To learn the different Optimization techniques.
3	To practice the Classical Optimization technique, Single variable optimization technique & Multi-variable optimization technique.
4	To realize Taguchi Method.
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Understand the variety of different types of models and simulations and the different ways in which they are used.
CO2	To understand the optimization process.
CO3	Use of different modeling and simulation techniques for the optimization process.
CO4	Understand Taguchi method for experimentation.

Assignment No.	Assignment Contents	Hours
<b>Assignment 1</b>	Assignment on Research Modeling Simulation	<b>1 Hr</b>
<b>Assignment 2</b>	Assignment on Simulation	<b>1 Hr</b>
<b>Assignment 3</b>	Assignment on Optimization Techniques: Classical Optimization Techniques	<b>1 Hr</b>

<b>Assignment 4</b>	Assignment on Single-variable Optimization Techniques	<b>1 Hr</b>
<b>Assignment 5</b>	Assignment on Multi-variable Optimization Techniques	<b>1 Hr</b>
<b>Assignment 6</b>	Assignment on Taguchi Method	<b>1 Hr</b>

### **Learning Resources:**

#### **Text Books**

1	Trochim, William M.K. (2003), 2/e, Research Methods, (Biztantra, Dreamtech Press, New Delhi), ISBN :81-7722-372-0
2	Montgomery, Douglas C., &Tunger, George C. (2007). 3/e, Applied Statistics & Probability for Engineers, (Wiley India).

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2	Jeff Wu, —Experiments: Planning, Analysis and Parameter Design, John Wiley,2000.
3	Fox R.L., —Optimization Methods for Engineering Design, Addison Wesley,1971

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPCCMDE102 Course Name: Solid Mechanics</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To prepare the students to succeed as designer in industry/technical profession.
2	To provide students with a sound foundation in solid mechanics required to apply in solving industrial problems .
3	To train the students with good design engineering concepts required for safe and efficient design, construction, installation, inspection and testing of structural parts of the mechanical system.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Solve the problems related to theory of elasticity, plane stress and plane strain with the knowledge of equilibrium equation, compatibility equation, stress function and biharmonic equation.
CO2	Analyze two dimensional problems in rectangular co- ordinates and polar co-ordinates.
CO3	Find shear centre for thin walled open sections, beam, etc.
CO4	Determine membrane stresses in shell and storage vessels.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Plane stress and plane strain:</b> Differential equations of equilibrium, Boundary conditions, Compatibility, Stress functions and Bi-harmonic equation	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Two dimensional problems in Rectangular coordinates:</b> Applications to polynomials in rectangular coordinates, Saint-Venant's principle idation	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Two dimensional problems in polar coordinates:</b> General equations in polar coordinates, Pure bending of curved bars, Strain components in polar coordinates, Rotating discs, stresses in a circular discs.	<b>6 Hrs</b>

<b>Unit 4</b>	<b>Shear center:</b> Shear stress distribution and shear centre for thin walled open sections. Bending of Beams, energy methods, Introduction to elastic stability, plasticity	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Torsion:</b> Torsion of bars with elliptical square and rectangular cross section Membrane analogy, Hydro dynamical analogy, Torsion of hollow and thin tubes	<b>6 Hrs</b>
<b>Unit 6</b>	<b>Membrane stresses in shell and storage vessels,</b> Shells and vessels of uniform strength. <b>Contact stresses:</b> Problem of determining contact stresses, Assumption Expressions for principal stresses, Examples	<b>7 Hrs</b>

### Learning Resources:

#### Text Books

1	S. Timoshenko and J.W. Goodier —Theory of Elasticity  MGH book coLtd Sadhu Singh – Theory of Elasticity, Khanna Publisher
2	Statics and Mechanics of Materials: An Integrated Approach , Riley, Sturges and Morris. Wiley, 2ndEdition.

#### Reference Books

1	Chakrabarty, —Theory of Plasticity , McGraw-Hill Book Company, New York1990
2	Timoshenko.S.and Young D.H. – —Elements of strength materials Vol. I and Vol. III. T. Van Nostrand Co-Inc Princeton-N.J.1990

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPCCMDE102T Course Name: Solid Mechanics Tutorial</b>		
Teaching Scheme	Credit	Evaluation Scheme
Tutorial: 01 Hours/Week	01	ISA: 25 Marks ESE: 00 Marks

**Course Objectives:** The objective of the course is to

1	To prepare the students to succeed as designer in industry/technical profession.
2	To provide students with a sound foundation in solid mechanics required to apply in solving industrial problems .
3	To train the students with good design engineering concepts required for safe and efficient design, construction, installation, inspection and testing of structural parts of the mechanical system.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Solve the problems related to theory of elasticity, plane stress and plane strain with the knowledge of equilibrium equation, compatibility equation, stress function and biharmonic equation.
CO2	Analyze two dimensional problems in rectangular co- ordinates and polar co-ordinates.
CO3	Find shear centre for thin walled open sections, beam, etc.
CO4	Determine membrane stresses in shell and storage vessels.

<b>Assessment No.</b>	<b>Assessment Contents</b>	<b>Hours</b>
<b>Assessment 1</b>	Assessment on Plane stress and plane strain	<b>1 Hr</b>
<b>Assessment 2</b>	Assessment on Two dimensional problems in Rectangular coordinates	<b>1 Hr</b>
<b>Assessment 3</b>	Assessment on Two dimensional problems in polar coordinates	<b>1 Hr</b>
<b>Assessment 4</b>	Assessment on Shear center	<b>1 Hr</b>

<b>Assessment 5</b>	Assessment on Torsion	<b>1 Hr</b>
<b>Assessment 6</b>	Assessment on Membrane stresses in shell and storage vessels	<b>1 Hr</b>

**Learning Resources:**

**Text Books**

1	S. Timoshenko and J.W. Goodier —Theory of Elasticity  MGH book coLtd Sadhu Singh – Theory of Elasticity, Khanna Publisher
2	Statics and Mechanics of Materials: An Integrated Approach , Riley, Sturges and Morris. Wiley, 2ndEdition.

**Reference Books**

1	Chakrabarty, —Theory of Plasticity , McGraw-Hill Book Company, New York1990
2	Timoshenko.S.and Young D.H. – —Elements of strength materials Vol. I and Vol. III. T. Van Nostrand Co-Inc Princeton-N.J.1990

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE1031 Course Name: Process Equipment Design (Program Elective-I)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To acquire basic understanding of process design parameter.
2	To acquire complete knowledge of design procedures for commonly used process equipment and their attachments (e.g. high pressure vessels, supports etc. internal and external pressure vessels, tall vessels,
3	To make students understand and learn about the Piping Design and process equipment design.
4	To acquire knowledge of Process Control, manufacture, inspection and erection of process equipment and Applications of CAD to process Equipment Design

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of basics of process equipment design and important parameters of equipment design.
CO2	Considerably more in-depth knowledge of the major subject and ability to design internal pressure vessels and external pressure vessels.
CO3	Ability to design special vessels (e.g. tall vessels) and various parts of vessels (e.g. heads).
CO4	Knowledge of Piping Design and process equipment design.
CO5	Knowledge of applications of CAD to process Equipment Design

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Process Design Parameters:</b> Basic concepts in process design, block diagrams for flow of processes, material flow balance. Design pressures – temperatures, design stresses, factor of safety, minimum shell thickness and corrosion allowance, weld joints efficiency, design loading, stress concentration and thermal stresses, failure criteria, optimization technique such as Lagrange's multiplier and golden section method, cost and profitability	<b>7 Hrs</b>

	estimation. Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA.API-650, BS-1500 & 1515	
<b>Unit 2</b>	<b>Design of Cylindrical and Spherical Vessels:</b> Thin and thick walled cylinder analysis, design of end closers, local stresses due to discontinuity or change of shape of vessel, vessel opening compensation, design of standard and non-standard flanges, design of vessels and pipes under external pressure, design of supports for process vessels	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Design of Tall Vessels and Large Storage Tanks:</b> Determination of equivalent stress under combined loadings including seismic and wind loads application of it to vertical equipment like distillation column. Design of <b>Thick Walled High Pressure Vessels:</b> Design by various theories of failure, construction of these vessels with high strength steel and other special methods.	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Process Equipment Design:</b> Storage vessels, reaction vessels, agitation and mixers, heat exchangers, filters and driers, centrifuges. Code practices, selection and specification procedures used in design. Selection of pumps, compressors, electrical equipments and auxiliary services, safety, etc Planning, manufacture, inspection and erection of process equipment like pressure vessels, chimneys, ducting, heat exchangers, pulverizing equipment, etc. protective coatings, lining of vessels	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Process Piping Design:</b> Flow diagrams and pipe work symbols, design of layout of water, steam and compressed air pipes work, pipe fitting, linings and flanged connections. Types of valves used on pipe line. Fabrication of pipe lines, expansion joints and pipe supports	<b>7 Hrs</b>
<b>Unit 6</b>	<b>Process Control:</b> Fundamentals of process measurements and control modern control devices and other controls of major unit operation and processes. Applications of CAD to Process Equipment Design	<b>7 Hrs</b>

### **Learning Resources:**

#### **Text Books**

1	Process Equipment Design : By Dr. M.V. Joshi
2	Process Equipment Design : By Browell and Young

#### **Reference Books**

1	Plant Design and Economics : Max and TimasulausKalus – McGraw Hill.
2	Industrial Pipe Work : D.N.W. Kentish, Mc GrawHill
3	Pressure Vessel Design Hand Book : H .Bedna

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE1032 Course Name: Material Handling Equipment Design (Program Elective-I)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To acquire basic understanding of material handling equipments.
2	To acquire complete knowledge of design of mechanical handling equipments.
3	To make students understand and learn about the design of load lifting attachments.
4	To acquire knowledge of Study of systems and Equipments used for Material Storage equipment and Material Handling / Warehouse Automation and Safety considerations.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of material handling equipments.
CO2	Considerably more in-depth knowledge of the major subject and ability to design of mechanical handling equipments.
CO3	Ability to design load lifting attachments.
CO4	Knowledge of Equipments used for Material Storage equipment.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Elements of Material Handling System:</b> Importance, Terminology, Objectives and benefits of better Material Handling; Principles and features of Material Handling System; Interrelationships between material handling and plant layout, physical facilities and other organizational functions; Classification of Material Handling Equipments.	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Selection of Material Handling Equipments:-</b> Factors affecting for selection; Material Handling Equation; Choices of Material Handling Equipment; General analysis Procedures; Basic Analytical techniques; The unit load concept; Selection of suitable types of systems for applications ; Activity cost data and economic analysis for design of components of Material	<b>6 Hrs</b>

	Handling Systems; functions and parameters affecting service; packing and storage of materials.	
<b>Unit 3</b>	<b>Design of Mechanical Handling Equipments:- [A]</b> Design of Hoists: - Drives for hoisting, components, and hoisting mechanisms; rail traveling components and mechanisms; hoisting gear operation during transient motion; selecting the motor rating and determining breaking torque for hoisting mechanisms. [B] 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.	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Design of load lifting attachments:-</b> 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.	<b>6 Hrs</b>
<b>Unit 5</b>	<b>Study of systems and Equipments used for Material Storage:-</b> Objectives of storage; Bulk material handling; Gravity flow of solids through slides and	<b>7 Hrs</b>
<b>Unit 6</b>	chutes; Storage in bins and hoppers; Belt conveyors; Bucket-elevators; Screw conveyors; Vibratory Conveyors; Cabin conveyors; Mobile racks etc.	<b>7 Hrs</b>

### **Learning Resources:**

#### **Text Books**

1	Kulwiac R. A., ‘Material Handling Hand Book’, 2nd edition, John Willy Publication, New York.
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#### **Reference Books**

1	N. Rudenko, ‘Material Handling Equipments’, Peace Publishers, Moscow.
2	James M. Apple, ‘Material Handling System Design’, John-Willwy and Sons Publication, New York.
3	John R. Immer, ‘Material Handling’ Mc Graw Hill Co. Ltd., New York.

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE1033 Course Name: Product Design and Development (Program Elective-I)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To acquire basic understanding of product design & development
2	To acquire complete knowledge of design of Consumer Product.
3	To make students understand and learn about the Economics Considerations.
4	To make students understand and learn about the Economics Considerations.
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of product design & development
CO2	Considerably more in-depth knowledge of the major subject and ability to design of Consumer Product.
CO3	Knowledge of Economics Considerations.
CO4	Deeper knowledge of design Organization, Value Engineering and Product Design.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction to product design:</b> Approach industrial product based on idea generation and innovativeness (and inventiveness) to meet the needs of the developing society. Design and development process of industrial products, various steps such as creative process involved in idea of marketing, The Designer- his role, myth and reality, the industrial design organization, basic design considerations, Role of Aesthetics in product design, Functional design practice. Use of modelling technique, prototype designs, conceptual design.	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Design for Production:</b> Producibility Requirements in the design of machine components, Forging design, Pressed component design, Casting design for economical moulding, eliminating defects and features to aid handling, Design for machining ease, the role of process Engineer, Ease of location and	<b>7 Hrs</b>

	Clamping, Some additional aspects of production design, Design of powder metallurgical parts.	
<b>Unit 3</b>	<p><b>a) Industrial Product Design:</b> General design situations, sailing specifications, requirements and ratings, their importance in the design. Study of market requirements and manufacturing aspects of industrial designs. Aspects of ergonomic design of machine tools, testing equipments, instruments, automobiles, process equipments etc. convention of style, form and color of industrial design.</p> <p><b>b) Design of Consumer Product:</b> Design concepts of consumer products, specification requirements and rating of their importance in design, functions and use, standard and legal requirements, body/dimensions. Ergonomic considerations, interpretation of information, conversions for style, forms, colors.</p>	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Economics Considerations:</b> Selection of material, design for production, use of standardization, value analysis and cost reduction, maintenance aspects of product design. Economic Factors Influencing Design: Product value, Design for safety, reliability and Environmental considerations, Manufacturing operations in relation to design, Economic analysis, profit and competitiveness, break even analysis, Economics of a new product design (Samuel Eilon Model)	<b>7 Hrs</b>
<b>Unit 5</b>	Value Engineering and Product Design: Introduction, Historical perspective, Value, Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, The value Analysis Job Plan, Creativity, Steps to problem solving and value analysis, Value Engg. Idea generation check list, Cost reduction, materials and process selection in value engineering. Introduction to TRIZ methodology.	<b>7 Hrs</b>
<b>Unit 6</b>	Design Organization: Organization structure, designer's position, drawing office procedure, standardization, record keeping, and legal product of design patents.	<b>7 Hrs</b>

### Learning Resources:

#### Text Books

1	Product Design and Development by Karl T Ulrich and Steven d. eppinger
2	Product Design and Development by AK Chitale and Gupta
3	Design of Systems and Devices by Middendorf Marcel Dekker

#### Reference Books

1	Industrial design for engineers – W. H. Mayall
2	Engineering of Creativity: Introduction to TRIZ Methodology of Inventive Problem Solving By SemyonSavransky
3	Engineering design conceptual stage – M. J. French

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE1041 Course Name: Robotics (Program Elective-II)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To acquire basic understanding of robot Fundamentals.
2	To acquire complete knowledge of Manipulator Kinematics, Robotics Dynamics and Trajectory planning
3	To make students understand and learn about Robot Sensors and controls.
4	To acquire knowledge of robot vision, programming languages and Futuristic topics in Robotics
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of basics of robot Fundamentals
CO2	Considerably more in-depth knowledge of Manipulator Kinematics, Robotics Dynamics and Trajectory planning
CO3	Knowledge about Robot Sensors and controls.
CO4	Deeper knowledge of robot vision, programming languages
CO5	Knowledge of Futuristic topics in Robotics

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Robot Fundamentals:</b> Definitions, History of robots, present and future trends in robotics, Robot classifications, Robot configurations, Point to Point robots, Continuous Path robots, Work volume, Issues in design and controlling robots Repeatability, Control resolution, spatial resolution, Precision, Accuracy, Robot configurations, Point to Point robots, Continuous Path robots, Work volume, Applications of robots. Drives used in robots- Hydraulic, Pneumatic and Electric drives, Comparison of drive systems and their relative merits and demerits.	<b>7 Hrs</b>

<b>Unit 2</b>	<b>Manipulator Kinematics:</b> Matrix Algebra, Inverse of matrices, rotational groups, matrix representations of coordinate transformation, transformation about reference frame and moving frame Forward & Inverse Kinematics examples of 2R, 3R & 3P manipulators, Specifying position and orientation of rigid bodies Euler's angle and fixed rotation for specifying position and orientation Homogeneous coordinate transformation and examples D-H representation of kinematics linkages Forward kinematics of 6R manipulators using D-H representations Inverse kinematics of 6R manipulators using D-H representations, Inverse Kinematics geometric and algebraic methods.	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Trajectory planning:</b> Introduction, general considerations in path description and generation, joint space schemes, Cartesian space schemes, path generation in runtime, planning path using dynamic model point to point and continuous trajectory , 4-3-4 & trapezoidal velocity strategy for robots.	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Robot Sensors:</b> Internal and external sensors, position- potentiometric, optical sensors ,encoders - absolute, incremental ,touch and slip sensors velocity and acceleration sensors, proximity sensors, force & torque sensors, laser range finder, camera. Micro-controllers, DSP, centralized controllers, real time operating systems.	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Robot Controllers:</b> Essential components-Drive for Hydraulic and Pneumatic actuators, H-bridge drives for Dc motor Overload over current and stall detection methods, example of a micro-controller/ microprocessor based robot Controller. <b>Robot Vision:</b> Introduction, Image acquisition, Illumination Techniques, Image conversion, Cameras, sensors, Camera and system interface, Frame buffers and Grabbers, Image processing, low level & high level machine vision systems	<b>7 Hrs</b>
<b>Unit 6</b>	<b>Robot Programming languages:</b> Introduction the three level of robot programming, requirements of a robot programming language, problems peculiar to robot programming languages. <b>Futuristic topics in Robotics:</b> Micro-robotics and MEMS (Microelectro mechanical systems ), fabrication technology for Micro-robotics, stability issue in legged robots, under-actuated manipulators, telecheirs.	<b>7 Hrs</b>

### Learning Resources:

#### Text Books

1	S.R.Deb, —Robotics Technology and Flexible Automation —, Tata Mc Graw Hill 1994
2	M.P.Groover, M. Weiss R.N. Nagel, N.G. Odrey — Industrial Robotics (Technology, Programming and application s) , McGraw, Hill 1996
3	K.S.Fu, R.C.Gonzalez and C.S.G.Lee,—Robotics: Control, sensors, vision and inintelligence —, MCGraw-Hill.1987.

## Reference Books

1	J.J.Craig, introduction to Robotics, Addison-wesely1989.
2	Klafter, Richard D., et al —RoboticsEngineeringI, PhI, 1996.
3	ZeuchNello,IApplying Machine Vision —, john Wiley and sons, 1988.

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE1042 Course Name: Machine Tool Design</b> <b>(Program Elective-II)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To acquire basic understanding of Machine tool design.
2	To acquire complete knowledge design of machine tool structure, guide ways and power screws.
3	To make students understand and learn about spindle and spindle support.
4	To acquire knowledge of dynamics , automation and controls of machine tools.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of basics of Machine tool design
CO2	Considerably more in-depth knowledge of design of machine tool structure, guide ways and power screws
CO3	Ability to design spindle and spindle support
CO4	Knowledge of dynamics, automation.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction:</b> Classification of machine Tools, Elements of machine tools, selection of speed and feed, various types of clutch systems, tool drives and mechanism, general requirements of machine tool design process as applied to machine tools, layout of machine tool, various motions introduced in machine tools, parameters defining limits of motions. Requirements of machine, tools drives, mechanical and hydraulics transmission used in machine drives their elements	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Design of machine tool structure:</b> Function of machine tool structure and their requirements. Design criteria, materials, Strength and Rigidity consideration,	<b>6 Hrs</b>

	process capability and compliance, static and dynamic stiffness, basic design procedure, design items like beam, column, housing, rams, etc.	
<b>Unit 3</b>	<b>Design of guide ways and power screws:</b> Function and types of guide ways, design of slide ways, force analysis of Lathe guide ways, design of antifriction guide ways, design of power screws.	<b>5 Hrs</b>
<b>Unit 4</b>	<b>Design of Spindle and spindle support:</b> Function of spindle unit requirement, material of spindles, design calculations design of antifriction bearings, sliding bearing used for spindles	<b>4 Hrs</b>
<b>Unit 5</b>	<b>Dynamics of machine Tools :</b> Vibration of machine tools and dynamic rigidity: Effect of vibrations, source of vibrations, self excited vibration, single degree of freedom chatter, velocity principle and related models, regenerative principles, chatter in lathe, drilling, milling & grinding, machine tool elastic system, general procedure for assessing Dynamic stability of equivalent elastic system.	<b>7 Hrs</b>
<b>Unit 6</b>	<b>Automation:</b> Automation drives for machine tools, Degree of automation, Semi automation, analysis of collect action, design of collect, bar feeding mechanism, tooling layout, single spindle mechanism, analysis, swiss type automatic machine. Loading and unloading. Transfer- devices, Modulator- design concept, in process gauging.  <b>Introduction to machine tool control:</b> Control system of machine tools: control, mechanical, electrical, hydraulic, numeric and fluidic. Basic principle of control, hydraulic controls, fluid controls, numerical controls, feedback systems, Primary systems programming.	<b>11 Hrs</b>

### Learning Resources:

#### Reference Books

1	Machine tool design – N. K. Mehta, 1984, Tata McGraw Hill Publishing Co .Ltd.
2	Principles of Machine tool – G. C. Sen and A. Bhattacharyya, New Central book agency ,Calcutta.
3	Design of machine tool – S. K. Basu, Allied Publishers Bombay.
4	Design principles of metal cutting machine tools – F. KoenigaBerger
5	Machine tools design by Mehta: Tata McGraw-Hill
6	Principles of machine tools by Sen et al Central Book Agency
7	Machine Tool Design by Bassu& Pal: Oxford &IBH
8	Machine tool Design vol. i to iv by Acherken: Mir Publishers
9	Design Principles of Metal cutting machine tools: Koenigsberger: Pergamon

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE1043 Course Name: Advanced Design Engineering (Program Elective-II)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To teach some advanced topics in stress analysis such as fatigue and creep
2	To teach analysis of springs used in systems.
3	To teach hazard and reliability analysis.
4	To teach how to modify the design of system such as Cam-follower system, etc.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Design, cam-follower system for high speeds for any prescribed input motion.
CO2	Find stresses in springs used in systems.
CO3	Use the Knowledge of fatigue and creep stresses in design of system
CO4	Evaluate reliability of components and systems from failure data analysis

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Engineering Statistics:</b> Analysis of variance (ANOVA), factorial design and regression analysis, Reliability theory, Design for reliability, Hazard Analysis and fault tree analysis.	<b>5 Hrs</b>
<b>Unit 2</b>	<b>Fatigue and creep:</b> Introduction, Fatigue strength, factors affecting fatigue behavior, influence of superimposed 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 ,	<b>7 Hrs</b>

	exponential creep law , Hyperbolic sine creep law , stress relaxation , bending etc.	
<b>Unit 3</b>	<b>Optimization:</b> Introduction, multivariable search methods, linear and geometric programming, structural and shape optimization and simplex method.	<b>6 Hrs</b>
<b>Unit 4</b>	<b>Composite materials:</b> Composite materials and structures , classical lamination theory , elastic stress analysis of composite material , fatigue strength improvement technique , stresses , stress concentration around cutouts in composite laminate , stability of composite plate and shells , hybrid materials , applications.	<b>6 Hrs</b>
<b>Unit 5</b>	<b>Design for materials and processes:</b> Design for brittle fracture, Design for fatigue failure, design for different machining process, assembly and safety etc.	<b>6 Hrs</b>
<b>Unit 6</b>	<p><b>Design of Mechanical components:</b></p> <p><b>Gear Design:</b> Involute Gears, tooth thickness, interference, undercutting, Rack shift, profile modification of spur and helical gears etc.</p> <p><b>Spring Design:</b> Vibration and surging of helical springs, helical springs for maximum space efficiency, analysis of Belleville springs, ring springs, volute springs and rubber springs, Design for spring suspension.</p> <p><b>Design for miscellaneous components (To be detailed):</b> Cam shaft with valve opening mechanism, piston,cylinder, connecting rod etc.</p> <p><b>Cams:</b> Basic curves, cam size determination, calculating cam profiles, advanced curve, polydyne cams, dynamics of high speed cam systems, surface materials, stresses and accuracy, ramps.</p>	<b>10 Hrs</b>

### Learning Resources:

#### Reference Books

1	Mechanical Design Analysis – M.F.Spotts
2	Machine Design – Robert Norton
3	Mechanical Metallurgy – G.E. Dieter
4	Engineer Design : A material and processing approach – G.E. Dieter
5	Mechanical Springs – A.M.Wahl.
6	Practical Gear Design – D.W.Dudley.

Tatyasaheb Kore Institute of Engineering and Technology, Warananagar First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
Course Code: 2501PGPEMDE1051 Course Name: Electric Vehicle (Program Elective-III)		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To acquire basic understanding of Electric vehical Technology
2	To make the student conversant with power sources of todays and future EV.
3	To prepare the students for a career in the drastically changing automotive industry.
4	To acquaint the student with prerequisite for higher studies in Electric Vehicle
5	To make the students aware with different areas of research in the field of Electric Vehicle
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	To Understand the basic knowledge of electric vehicle technology.
CO2	To Understand the basic knowledge of electric vehicle technology.
CO3	To Choose various configurations of an electric vehicle
CO4	To Configure power transmission system in electric vehicle.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction to Electric Vehicles:</b> Energy crises, Need of future transportation, Introduction and overview of Electric Drive Technologies and Configurations, Traction power requirement for vehicle propulsion under different road and speed condition, EV Indian strategies, policies, R&D and Collaboration, Introduction to Energy Storage	<b>5 Hrs</b>
<b>Unit 2</b>	<b>Batteries for Electric Vehicles:</b> Electrochemical Batteries Reactions and Thermodynamic, Voltage, Specific power and Energy, Working of Pb-Acid batteries, Ni-Fe, Ni- Cd, Ni-MH Batteries, Li- Polymer, Li-ion, Battery selection for Electric Vehicle, Regenerative Braking for battery charging,	<b>7 Hrs</b>

	Effects of Current Density and Heat on Battery Cycle and Life. Battery Storage, Battery Pack Design	
<b>Unit 3</b>	<b>Battery Charging Technology for Electric Vehicles:</b> Types of battery charging, Normal charging, Opportunity charging, Fast charging, Battery swapping. Battery Charging algorithms, Improve the charging efficiency, Reduce the charging time, enhancing the battery life, Protect the battery, Constant current and constant voltage Charging, Multistage charging (MSC), Pulse Charging, Trickle Charging (TC), Wire and Wireless charging, Charging station infrastructure.	<b>8 Hrs</b>
<b>Unit 4</b>	<b>Electric Motors in Electric Vehicles:</b> Electric Motors used in electric vehicles, DC motors, Induction motors, Permanent Magnet motors, Switched Reluctance motors., Torque speed characteristics of above mentioned motors, Comparison and its layout in EV, Selection of motor for EV, Motor location and drive from motor to wheels.	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Motor control in Electric Vehicles:</b> Power conversion required in EV. Principle of operation of power electronics devices like: SCR, TRIAC, DIAC, GTO, MOSFET, IGBT and power BJT, Battery to Motor with speed control, Regenerative Braking requirements, Bi-directional and multiple input to single output power conversion in EV. Power conversion required for DC charging and AC charging on board and off board	<b>8 Hrs</b>
<b>Unit 6</b>	<b>Safety, Norms and Testing of Electric Vehicles:</b> Type approval procedure for electric and hybrid electric vehicles, Government scheme, Electric vehicle conductive AC charging system, DC charging system, V2X technology like V2 home, V2Grid, Self-driving from level 1 to level 5, Autonomous drivin	<b>6 Hrs</b>

Reference Books	
1	James Larminie and John Lowry, Electrical Vehicle Technology Explained, John Wiley and Sons Ltd., 2nd Edition WSE 2015.
2	Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamental. CRC Press, 2nd Edition, Wiley 2011
3	C.C. Chan, K.T. Chau, Modern Electric Vehicle Technology, Oxford Publication, New York, 1st edition 2000

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE1052 Course Name: Advanced Finite Element Analysis (Program Elective-III)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To teach the fundamentals of finite element method with emphasize on the underlying theory, assumption and modelling issues.
2	To make students to study the 1D and 2D analysis for different field problems.
3	To make students to study the 3D analysis for different field problems.
4	To provide hands on experience using finite element software to model, analyze and design systems of mechanical engineering

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Explain the knowledge of Mathematical modeling and FEM.
CO2	Design Engineering problems by using FEM. Students will develop confidence for self-education and ability for lifelong learning.
CO3	Formulate and solve Design Engineering problems by using advanced tools. Students will have an ability to carry out research and in the area of Mechanical engineering
CO4	Design machines, systems, and projects required for industry based on the static analysis of machine components.
CO5	Use modern tools, software, and equipments to analyze and solve the problems

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction to Finite Element Method:</b> Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design., Mathematical Preliminaries, Differential equations formulations, Variational formulations, weighted residual methods	<b>7 Hrs</b>
<b>Unit 2</b>	<b>One-Dimensional Elements-Analysis of Bars and Trusses:</b> Basic Equations and Potential Energy Functional, 1-D Bar Element, trusses, Admissible displacement function, Strain matrix, Stress recovery, Element equations,	<b>7 Hrs</b>

	Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multi-point constraint, 2- D Bar Element, Shape Functions for Higher Order Elements	
<b>Unit 3</b>	<b>Two-Dimensional Elements-Analysis of Plane Elasticity Problems:</b> Three-Noded Triangular Element(TRIA3),Four-noded quadrilateral element	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Axi-symmetric Solid Elements:</b> Analysis of Bodies of Revolution under axi-symmetric loading: Axisymmetric Triangular and Quadrilateral Ring Elements. Shape functions for Higher Order Elements	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Three-Dimensional Elements and Beam Elements:</b> Applications to Solid Mechanics Problems: Basic Equations and Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Shape functions for Higher Order Elements <b>Beam Elements:</b> Analysis of Beams and Frames: 1–D Beam Element, 2–D Beam Element, Problems, plate bending and shell elements	<b>7 Hrs</b>
<b>Unit 6</b>	<b>Heat Transfer and Fluid Flow:</b> Steady state heat transfer, 1 D heat conduction governing equation, boundary conditions, One dimensional element, Functional approach for	<b>7 Hrs</b>

### Learning Resources:

#### Reference Books

1	Rao S. S. —Finite Elements Method in Engineering— 4th Edition, Elsevier,2006
2	Frank L. Stasa,   Applied finite Element Analysis for Engineers  , CBS International Edition,1985
3	J.N.Reddy, —Finite Element Method— McGraw -Hill International Edition.
4	Bathe K. J. Finite Elements Procedures, PHI. Cook R. D., et al. —Concepts and Application of Finite Elements Analysis— 4th Edition, Wiley & Sons,2003
5	Chandrupatla T. R., —Finite Elements in engineering— 2nd Editions, PHI,2007.2
6	Zeinkovich, —The Finite Element Method for Solid and Structural Mechanics

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE1053 Course Name: Reverse Engineering</b> <b>(Program Elective-III)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To acquire basic understanding of Reverse Engineering.
2	To acquire complete knowledge of tools for Functionality- dimensional- developing technical data - digitizing techniques, etc.
3	To make students understand History of Reverse Engineering – Preserving and preparation for the four stage.
4	To acquire knowledge of data management and integration

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of basics of Reverse Engineering.
CO2	Considerably more in-depth knowledge of tools for Functionality.
CO3	Knowledge of Preserving and preparation for the four stage
CO4	Deeper knowledge of data management and integration.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction:</b> Scope and tasks of RE - Domain analysis- process of duplicating	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Tools for</b> Functionality- dimensional- developing technical data – digitizing techniques - construction of surface model - solid-part material- characteristics evaluation -software and application- prototyping – verification	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Concepts</b> History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation	<b>7 Hrs</b>

<b>Unit 4</b>	<b>Data Management</b> Data reverse engineering – Three data Reverse engineering strategies – Definition – organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software	<b>7 Hrs</b>
<b>Unit 5</b>	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	<b>7 Hrs</b>
<b>Unit 6</b>	<b>Integration</b> 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	<b>7 Hrs</b>

### **Learning Resources:**

#### **Reference Books**

1	Design Recovery for Maintenance and Reuse, T J Bigger staff, IEEE Corpn. July1991
2	White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology,1994
3	Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill,1994.
4	Data Reverse Engineering, Aiken, Peter, McGraw-Hill,1996
5	Reverse Engineering, Linda Wills, Kluiver Academic Publishers,1996
6	Co-ordinate Measurement and reverse engineering, Donald R. Honsa, ISBN 1555897, American Gear Manufacturers Association

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGLCMDE106 Course Name: Design Engineering Lab</b>		
Teaching Scheme	Credit	Evaluation Scheme
Practical: 4 Hours/Week	2	POE: 25 Marks ISA: 25 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To acquire basic understanding of Coordinate Measuring Machine, Turning Center (CNC Lathe) and Vertical Machining Center.
2	To acquire complete knowledge of measurement of vibration parameters, sound parameters.
3	To make students understand and learn about Experimental stress analysis methods.
4	To acquire knowledge Condition monitoring & signature analysis applications
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of Product Dimension Measurement using Coordinate Measuring Machine.
CO2	Ability to measure vibration parameters, sound parameters.
CO3	Ability to programming on Turning Center (CNC Lathe) and Vertical Machining Center
CO4	Considerably more in-depth knowledge of the major subject.
CO5	Deeper knowledge of Experimental stress analysis methods
CO6	Knowledge of Condition monitoring & signature analysis applications

Unit No.	Course Contents	Hours
1	Product Dimension Measurement using Coordinate Measuring Machine	4 Hrs
2	Measurement of vibration parameters using FFT analyzer	4 Hrs

3	Measurement of Sound parameters: a) Sound intensity level b) Sound Power level c) Sound Pressure level	4 Hrs
4	Condition monitoring & signature analysis applications.	4 Hrs
5	Vibration signature analysis of different existing machines such as Lathe,Grinder, Blower	4 Hrs
6	Bonding of strain gauges & Stress Analysis of Machine component by strain gauge technique	4 Hrs
7	Casting of Photoelastic model	4 Hrs
8	Stress Analysis of Machine component using photoelasticity	4 Hrs
9	Programming On Turning Center (CNC Lathe)	4 Hrs
10	Programming On Vertical Machining Center	4 Hrs

### Learning Resources:

#### Reference Books

1	B. C. Nakra& K. K. Choudhary, —Instrumentation, Measurement & Analysis Tata McGraw Hill Publications Pvt. Ltd., New Delhi
2	Earnest O Doebelin, —Measurement Systems: Applications & Design, McGraw Hill International
3	Rao, J.S. & Gupta K., "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984.
4	Dally and Riley, —Experimental Stress Analysis, McGraw Hill
5	Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, —Experimental Stress Analysis, Tata McGraw Hill
6	Sadhu Singh —Experimental Stress Analysis, Khanna publisher anics
7	Pabala B.S. — CNC machines
8	Jha B.K. CNC Programming

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGSWMDE107 Course Name: SEMINAR-I</b>		
Teaching Scheme	Credit	Evaluation Scheme
Practical: 2 Hours/Week	1	POE: 00 Marks ISA: 50 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To Identify, understand and discuss current, real-world issues
2	To Distinguish and integrate differing forms of knowledge and academic disciplinary approaches (e.g., humanities and sciences) with that of the student's own academic discipline (e.g., in agriculture, architecture, art, business, economics, education, engineering, natural resources, etc.). And apply a multidisciplinary strategy to address current, real-world issues.
3	To Improve oral and written communication skills.
4	To Improve presentation skills

<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Apply principles of ethical leadership, collaborative engagement, socially responsible behavior, respect for diversity in an interdependent world, and a service-oriented commitment to advance and sustain local and global communities.
CO2	Learn and integrate. Through independent learning and collaborative study, attain, use, and develop knowledge in the arts, humanities, sciences, and social sciences, with disciplinary specialization and the ability to integrate information across disciplines
CO3	Think and create. Use multiple thinking strategies to examine real-world issues, explore creative avenues of expression, solve problems, and make consequential decisions
CO4	Communicate. Acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication that demonstrates respect and understanding in a complex society

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	Seminar-I should be based on the literature survey on any topic relevant to 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.	<b>-- Hrs</b>

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPCCMDE201 Course Name: Vibration Engineering</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To understand the fundamentals of Vibration Theory.
2	To acquire complete knowledge of analysis of Two degree freedom system, Multidegree freedom system and Vibration of Continuous Systems.
3	To make students understand and learn about the Experimental Methods in Vibration Analysis.
4	To acquire knowledge of Analytical Dynamic Analysis, Non-Linear Vibrations and Random Vibration

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of fundamentals of Vibrations.
CO2	Considerably more in-depth knowledge of the major subject and ability to solve problems on Two degree freedom system, Multi degree freedom system.
CO3	Knowledge of Experimental Methods in Vibration Analysis.
CO4	Knowledge of Non-Linear Vibrations and Random Vibrations.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Fundamentals of Vibration:</b> Review of Single and Two degree freedom systems subjected to Forced and Motion Excitation. Response to arbitrary periodic and a periodic excitations Impulse response - Transient vibration - Laplace transformation formulation. Fourier transforms- definition, Relation to transfer functions, first order systems, applications. Basic Concepts like Passive, Semi- active and Active Parameters	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Two Degree Freedom System:</b> Optimum design of single, two degree of freedom systems, Vibration Absorber and Vibration isolators	<b>7 Hrs</b>

<b>Unit 3</b>	<b>Multi Degree Freedom System:</b> Normal mode of vibration - Flexibility matrix and stiffness matrix - Eigen value and Eigen vector – Orthogonal properties - Modal matrix - Modal analysis - Forced vibration by matrix inversion - Modal damping in forced vibration - Numerical methods of determining natural frequencies. <b>Vibration of Continuous Systems:</b> Systems governed by wave equations - Vibration of strings - Vibration of rods - Euler's equation for beams - Effect of Rotary inertia and shear deformation - Vibration of plates..	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Experimental Methods in Vibration Analysis:</b> Vibration instruments - Vibration exciters Measuring Devices - Analysis - Vibration Tests - Free and Forced Vibration tests. Collection of FRF, experimental modal analysis methods, Examples of vibration tests - Industrial case studies	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Non-Linear Vibrations:</b> Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Limit cycles-van der pol oscillator, Perturbation method, Chaos, Method of iteration, Self-excited oscillations, Lindstedt's Methods	<b>7 Hrs</b>
<b>Unit 6</b>	<b>Random Vibrations:</b> Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response	<b>7 Hrs</b>

### Learning Resources:

#### Reference Books

1	Rao, J.S. & Gupta K., "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd.,1984
2	Thomson, W.T., "Theory of Vibration with Applications" CBS Publishers and Distributors, New Delhi,1990
3	Den Hartog, J.P., "Mechanical Vibrations", Dover Publications,1990.
4	Rao, S.S., "Mechanical Vibrations", Addison Wesley Longman,1995
5	D.J. Ewins, Modal Testing: Theory and Practice, Research Press Ltd, Letch worth (Herefordshire,England)(1984)
6	Fundamentals of Mechanical Vibration. - S. Graham Kelly. 2 nd edition McGrawHill
7	Vibration: Fundamental and Practice, Clarence W. de Silva, CRC Press LLC,2000
8	Mechanical Vibrations - S. Graham Kelly, Schaum's Outlines, Tata McGraw Hill,2007

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPCCMDE201T Course Name: Vibration Engineering Tutorial</b>		
Teaching Scheme	Credit	Evaluation Scheme
Tutorial : 01 Hours/Week	01	ISA: 25 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To understand the fundamentals of Vibration Theory.
2	To acquire complete knowledge of analysis of Two degree freedom system, Multidegree freedom system and Vibration of Continuous Systems.
3	To make students understand and learn about the Experimental Methods in Vibration Analysis.
4	To acquire knowledge of Analytical Dynamic Analysis, Non-Linear Vibrations and Random Vibration
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of fundamentals of Vibrations.
CO2	Considerably more in-depth knowledge of the major subject and ability to solve problems on Two degree freedom system, Multi degree freedom system.
CO3	Knowledge of Experimental Methods in Vibration Analysis.
CO4	Knowledge of Non-Linear Vibrations and Random Vibrations.

Assignment No.	Assignment Contents	Hours
Assignment 1	Assignment on Fundamentals of Vibration	<b>1 Hr</b>
Assignment 2	Assignment on Two Degree Freedom System	<b>1 Hr</b>
Assignment 3	Assignment on Multi Degree Freedom System	<b>1 Hr</b>
Assignment 4	Assignment on Experimental Methods in Vibration Analysis	<b>1 Hr</b>
Assignment 5	Assignment on Non-Linear Vibrations	<b>1 Hr</b>
Assignment 6	Assignment on Random Vibrations	<b>1 Hr</b>

**Learning Resources:****Reference Books**

1	Rao, J.S. & Gupta K., "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd.,1984
2	Thomson, W.T., "Theory of Vibration with Applications" CBS Publishers and Distributors, New Delhi,1990
3	Den Hartog, J.P., "Mechanical Vibrations", Dover Publications,1990.
4	Rao, S.S., "Mechanical Vibrations", Addison Wesley Longman,1995
5	D.J. Ewins, Modal Testing: Theory and Practice, Research Press Ltd, Letch worth (Herefordshire,England)(1984)
6	Fundamentals of Mechanical Vibration. - S. Graham Kelly. 2 nd edition McGrawHill
7	Vibration: Fundamental and Practice, Clarence W. de Silva, CRC Press LLC,2000
8	Mechanical Vibrations - S. Graham Kelly, Schaum's Outlines, Tata McGraw Hill,2007

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPCCMDE202 Course Name: Smart Materials and Structure</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	The course is designed to give an insight into the latest development regarding, Smart materials & their types.
2	To know High –Band width, Low strain smart sensors.
3	To Know smart Actuators.
4	To Understand smart composites
5	To know advances in smart structures and materials

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Ability to design sensors & actuators using smart (piezoelectric, shape memory alloys) materials.
CO2	Student understands high –Band width, Low strain smart sensors.
CO3	Ability to understand applications of smart actuators.
CO4	Ability to interpret emerging technical literature related to smart materials and structures and demonstrates knowledge in a project.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Overview of smart materials</b> Introduction to Smart Materials, Principles of Piezoelectricity, PerovskitePiezoceramic Materials, Single Crystalsvs Polycrystalline Systems, Piezoelectric Polymers,	<b>6 Hrs</b>
<b>Unit 2</b>	<b>Advanced Materials</b> Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect, Introduction to Electro- active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory	<b>6 Hrs</b>

	Effect, Shape Memory Alloys, Shape Memory Polymers, Electro-rheological Fluids, Magneto Rheological Fluids	
<b>Unit 3</b>	<b>High-band width, low strain smart sensors</b> Piezoelectric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteucci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors	<b>8 Hrs</b>
<b>Unit 4</b>	<b>Smart actuators</b> Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magneto volume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Controls	<b>8 Hrs</b>
<b>Unit 5</b>	<b>Smart composites</b> Review of Composite Materials, Micro and Macro-mechanics, Modelling Laminated Composites based on Classical Laminated Plate Theory, Effect of Shear Deformation, Dynamics of Smart Composite Beam, Governing Equation of Motion, Finite Element Modelling of Smart Composite Beams	<b>6 Hrs</b>
<b>Unit 6</b>	<b>Advances in smart structures &amp; materials</b> Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design	<b>6 Hrs</b>

### **Learning Resources:**

#### **Text Books**

1	Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2	Gauenzi, P., Smart Structures, Wiley, 2009
3	Cady, W. G., Piezoelectricity, Dover Publication.

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPCCMDE202T Course Name: Smart Materials and Structure Tutorial</b>		
Teaching Scheme	Credit	Evaluation Scheme
Tutorial: 01 Hours/Week	01	ISA: 25 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	The course is designed to give an insight into the latest development regarding, Smart materials & their types.
2	To know High –Band width, Low strain smart sensors.
3	To Know smart Actuators.
4	To Understand smart composites
5	To know advances in smart structures and materials
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Ability to design sensors & actuators using smart (piezoelectric, shape memory alloys) materials.
CO2	Student understands high –Band width, Low strain smart sensors.
CO3	Ability to understand applications of smart actuators.
CO4	Ability to interpret emerging technical literature related to smart materials and structures and demonstrates knowledge in a project.

Assignment No.	Assignment Contents	Hours
Assignment 1	Assignment on Overview of smart materials	<b>1 Hr</b>
Assignment 2	Assignment on Advanced Materials	<b>1 Hr</b>
Assignment 3	Assignment on High-band width, low strain smart sensors	<b>1 Hr</b>
Assignment 4	Assignment on Smart actuators	<b>1 Hr</b>
Assignment 5	Assignment on Smart composites	<b>1 Hr</b>
Assignment 6	Assignment on Advances in smart structures & materials	<b>1 Hr</b>

**Learning Resources:****Text Books**

1	Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2	Gauenzi, P., Smart Structures, Wiley, 2009
3	Cady, W. G., Piezoelectricity, Dover Publication.

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE2031 Course Name: Experimental Stress Analysis (Program Elective-IV)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To acquire basic understanding of Experimental stress analysis methods.
2	To acquire complete knowledge of Photoelasticity
3	To make students understand and learn about the strain gauges
4	To acquire knowledge of coating method, Holography and Moire technique

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of basics of Experimental stress analysis methods
CO2	Considerably more in-depth knowledge of the major subject and photoelasticity
CO3	Deeper Knowledge of Strain gauge technique.
CO4	knowledge of coating method
CO5	Knowledge of Holography and Moire technique
CO6	Knowledge of basics of Experimental stress analysis methods

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Photo Elasticity</b> :Arrangement of optical elements in a polar scope, Theory of photoelasticity, Plane & circular polariscope, Isoclinics and isochromatics <b>Model Materials</b> : Properties, selection and method of calibration. <b>Different methods of analysis:</b> Compensation technique, principle stresses separation technique, calibration methods fringe	<b>7 Hrs</b>

	Multiplication, scaling model to prototype, Application of photo elasticity for two dimensional models..	
<b>Unit 2</b>	<b>Three Dimensional Photoelasticity:</b> Stress locking in model materials, slicing technique, shear difference method. Scattered light photoelasticity, Dynamic photoelasticity	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Strain Gauges:</b> Electrical Resistance strain gauges: types, gauge factor, sensitivity, applications. Materials ,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.	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Coating Methods for stress analysis :</b> Coating stresses, Birefringent coatings (Photoelastic& Brittle coatings), coating sensitivity, coating materials, analysis of brittle- coating data.	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Holography:</b> Equation for plane waves and spherical waves Intensity – Coherence – Spherical radiator as an object (record process) Hurter –Driffeld curve reconstruction process General case. Holographic setup	<b>7 Hrs</b>
<b>Unit 6</b>	<b>Moire technique:</b> Geometrical approach – sensitivity of Moire data - data reduction in plane and out plane Moire methods – Moire photography – Moire grid production.	<b>7 Hrs</b>

### Learning Resources:

#### Text Books

1	Dally and Riley, —Experimental Stress Analysis . McGrawHill.
2	Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, —Experimental Stress Analysis . TataMcGrawHill.
3	Sadhu Singh —Experimental Stress Analysis . Khanna publisher.
4	Hand Book of Experimental Stress Analysis by Hyteneyi.

#### Reference Books

1	M. M. Frocht, —Photo elasticity Vol I and Vol II. John Wiley &sons.
2	Perry and Lissner, —Strain Gauge Primer .
3	Kuske, Albrecht & Robertson —Photo elastic Stress analysis . John Wiley &Sons.
4	Dave and Adams, —Motion Measurement and Stress Analysis .

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b>		
<b>First Year M. Tech. Department of Mechanical Engineering (Design Engineering)</b>		
<b>Course Code: 2501PGPEMDE2032 Course Name: Design for Sustainability and Life Cycle Cost (Program Elective-IV)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To acquire basic understanding of sustainability and design for sustainability.
2	To acquire complete knowledge of Integrated Sustainable Life Cycle Design and Life Cycle Costing
3	To make students understand and learn about Life Cycle Cost Models, Maintenance and Repair Costs
4	To acquire knowledge of Product Disposal Costs and Activity Based Life Cycle Costing

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of design for sustainability
CO2	Considerably more in-depth knowledge of the major subject and Life Cycle Design
CO3	Deeper Knowledge of Life Cycle Costing..
CO4	knowledge about Life Cycle Cost Models, Maintenance and Repair Costs
CO5	Knowledge of Product Disposal Costs and Activity Based Life Cycle Costing

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction:</b> History, definition, concept of product life cycle and life cycle cost (LCC), design for sustainability, product life cycle costing in the changing industrial scenario, the traditional approach to product/system selection, LCC approach to product system selection, introduction to reliability, maintainability, availability and life cycle cost. <b>Product Design for Sustainability:</b> Sustainability and product design, types of sustainability, environmental sustainability, and sustainment dominated products, technology	<b>7 Hrs</b>

	sustainment activities, technology obsolescence, technology insertion, technology monitoring and forecasting.	
<b>Unit 2</b>	<p><b>Integrated Sustainable Life Cycle Design:</b> Concept of product life cycle design, design for X (DFX), life cycle design methodologies, 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) and Life cycle assessment (LCA), Integrated sustainable life cycle design.</p> <p><b>Basics of Life Cycle Costing:</b> Cost issues in product life cycle design, theory of product life cycle costing, need for product life cycle costing, cost estimating approaches, parametric cost estimation, cost estimation by analogy, detailed cost estimation, and activity based cost estimation, life cycle costing application areas.</p>	<b>7 Hrs</b>
<b>Unit 3</b>	<p><b>Life Cycle Cost Models:</b> Introduction, classification, types of life cycle cost models and their inputs, general life cycle cost models and specific life cycle cost models, activity based life cycle cost models, applications of these models to typical industrial products, life cycle costing economics, time value of money and present value of life cycle cost.</p>	<b>7 Hrs</b>
<b>Unit 4</b>	<p><b>Modeling Maintenance and Repair Costs:</b> Factors influencing maintenance cost, types of maintenance costs, preventive and corrective maintenance cost estimation, manpower, maintenance material, spare and repair parts costs, maintenance cost estimation models, and maintenance cost data collection, stochastic point processes for repairable systems, methodology for planning renewal process and minimal repair process approach to model maintenance and repair costs.</p>	<b>7 Hrs</b>
<b>Unit 5</b>	<p><b>Modeling Product Disposal Costs:</b> Product end-of-life (EOL) strategies, factors influencing end-of- life strategies, product design for recyclability, compatibility analysis of product design for recyclability and reuse, material recycling at product EOL, system recycling cost, design for disassembly, disassembly cost analysis and estimating product disposal costs.</p>	<b>6 Hrs</b>
<b>Unit 6</b>	<p><b>Activity Based Life Cycle Costing:</b> General principles of activity based costing (ABC), ABC as applied to Life Cycle Costing, Identification life cycle stages, life cycle activities and cost drivers, development of LCC model, estimation of various LCC components, application of activity based costing to analyze LCC of industrial products/machines.</p>	<b>6 Hrs</b>

### Learning Resources:

#### Text Books

1

W.J. Fabrycky, Benjamin S. Blanchard, 1991, —Life-cycle Cost and Economic Analysis, Prentice Hall International Series in Industrial and Systems Engineering

2	B. S. Dhillon, 1989, —Life Cycle Costing: Techniques, Models, and Applications, Gordon and Breach Science Publishers.
3	Jan Emblemsvag, 2003, —Life-cycle costing: using activity-based costing and Monte Carlo methods to manage future costs and risks, John Wiley and Sons.
4	B. S. Dhillon, 2010, —Life cycle costing for engineers, CRC Press, Taylor and Francis Group.

### Reference Books

1	Alphonse J. Dell'Isola, Stephen J. Kirk, 1981, —Life cycle costing for design professionals, McGraw-Hill
2	Guangbin Yang, 2007, —Life cycle reliability engineering, John Wiley and Sons.
3	Fabio Giudice, Guido La Rosa, Antonino Risitano, 2006, —Product design for the environment: a life cycle approach, CRC/Taylor & Francis.
4	Tracy Bhamra, Vicky Lofthouse, 2007, —Design for sustainability: a practical approach, Gower Publishing, Ltd., 2007.
5	Sandborn, P., and Myers, J., 2008, —Designing Engineering Systems for Sustainability, Handbook of Performability Engineering, ed. K., B., Misra, Springer, London, pp.81-103.

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE2033 Course Name: Tribology (Program Elective-IV)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To acquire basic understanding of Tribology.
2	To acquire complete knowledge of friction and wear
3	To make students understand and learn about Bearings, Lubrication and Lubricants
4	To acquire knowledge of lubrication systems.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Gain knowledge of design for Tribology
CO2	Have considerably more in-depth knowledge of the major subject and friction and wear
CO3	Get deeper Knowledge of Bearings, Lubrication.
CO4	Have knowledge of Hydrostatic (externally-pressurized) &Elasto-Hydrodynamic Lubrication

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction:</b> Introduction to Tribology- General Tribology considerations in the design of gears, cams, reciprocating components, etc. Engine Tribology basics- Tribology aspects of engine components such as bearings, piston assembly, valve train and dive train components etc.	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Friction:</b> Nature of metal surfaces- surface properties- surface parameters and measurements. Friction-sliding friction-rolling friction characteristics of common metals and nonmetals- friction under extreme environments. Engine friction- Losses and engine design parameters.	<b>6 Hrs</b>
<b>Unit 3</b>	<b>Wear:</b> Economic role of wear-type of wear-wear mechanism-factors affecting wear- selection of materials for different wear situations-measurement of wear-	<b>6 Hrs</b>

	tribometers and Tribometry. Engine wear-mechanisms, wear resistance material and coatings and failure mode analysis	
<b>Unit 4</b>	<b>Bearings, Lubrication and Lubricants:</b> Theory of hydrodynamic lubrication-Generalized Reynolds Equation-Slider bearings-Fixed and pivoted shoe bearings-Hydrodynamic journal bearings-short and finite bearing-Thrust bearings-Sintered Bearing- Non Circular bearings and multi side surface bearings. Lubrication-type of lubricants-Properties and Testing –Service Classification of lubricants-Lubrication of tribological components-Lubrication systems- Lubricant monitoring, SOAP, Ferrography and other rapid testing methods for lubricants contamination.	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Hydrostatic (externally-pressurized) &amp;Elasto-Hydrodynamic Lubrication:</b> Hydrostatic bearing-basic concepts, bearing pad coefficient. Restrictors- Capillary, orifice and flow control valve-bearing characteristic number and performance coefficients-Flat, Conical and Spherical pad thrust bearing- Multirecess journal and thrust bearings-Air and gas lubricated bearings. Lubrication of Ball and roller bearings, cams and gears, selection and life estimation, fatigue and diagnostics.	<b>7 Hrs</b>
<b>Unit 6</b>	<b>Rheodynamic (static) Lubrication:</b> Non-Newtonian fluids, characteristics, Thixotropic, materials and Bingham solids, grease lubrication and stability. Tribology of components in extreme environments like vacuum, pressure, temperature; tribomonitoring and special applications; Tribology matching and selection, Tribometry, tribo-testing and standards	<b>7 Hrs</b>

### Learning Resources:

#### Text Books

1	Bowden F.P. & Tabor D., —Friction and Lubrication of solids, Oxford University Press, 1986. Ernest Rabinowicz, —Friction and Wear of materials, Inderscience Publishers, 1995.
2	Neale M.J., Tribology-: Hand Book", Butterworth, 1995.

#### Reference Books

1	Fuller D.D.,: —Theory and practice of Lubrication for Engineers, John Wiley sons, 1984.
2	Gross W. A.: —Gas film lubrication, Wiley, 1980.

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE2041 Course Name: Analysis and Synthesis of Mechanisms (Program Elective-V)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To prepare the students to succeed as designer in industry/technical profession.
2	To provide students with a sound foundation in kinematic and synthesis of machines and mechanisms
3	To train the students to apply complex number, matrices and algebra for analysis of mechanisms
4	To prepare the students to use modern software for kinematic and dynamic analysis of the mechanisms.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Solve the problems related to mechanisms of higher and lower pairs
CO2	Analyze four bar mechanisms
CO3	Carry out synthesis of planner mechanisms with two, three and four accuracy points.
CO4	Synthesize mechanisms using algebra methods
CO5	Analyze and synthesize mechanisms using complex numbers
CO6	Apply the knowledge of synthesis of mechanisms to robotics and automatically controlled mechanisms

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Basic Concepts:</b> Definitions and assumptions, planar and spatial mechanisms, kinematic pairs, degree of freedom. <b>Kinematic Analysis Of Complex Mechanisms:</b> velocity-acceleration analysis of complex mechanisms by the normal acceleration and auxiliary point methods.	<b>7 Hrs</b>

<b>Unit 2</b>	<b>Dynamic Analysis of Planar Mechanisms:</b> - 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.	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Curvature theory:</b> Fixed and moving centrodes, inflection circle, Euler-Savy equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell Mechanisms.	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Graphical Synthesis of Planar Mechanisms:</b> 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, Bermesterpoints, Synthesis for five accuracy points, Branch and order defects, Synthesis for path generation.	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Analytical synthesis of Planar Mechanisms:-</b> 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	<b>6 Hrs</b>
<b>Unit 6</b>	<b>Kinematic Analysis of Spatial Mechanisms:</b> Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms	<b>6 Hrs</b>

### Learning Resources:

#### Text Books

1	Theory of Machines and Mechanisms, A. Ghosh and A.K.Mallik, Affiliated East-West Press
2	Kinematic Synthesis of Linkages, R. S. Hartenberg and J. Denavit, McGraw-Hill
3	Mechanism Design – Analysis and Synthesis (Vol.1 and 2), A. G. Erdman and G.N. Sandor, Prentice Hall of India

#### Reference Books

1	Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, 2nd Ed., McGraw-Hill
2	Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L.Norton, Tata McGraw-Hill, 3rdEdition
3	Kinematics and Linkage Design, A.S.Hall, Prentice Hall of India

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE2042 Course Name: Vehicle Dynamics</b> <b>(Program Elective-V)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To understand the fundamentals of Vehicle dynamics.
2	To acquire complete knowledge of suspension, steering system
3	To make students understand and learn about vehicle stability
4	To acquire knowledge of vehicle handling and Aerodynamic Drag of Cars.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of fundamentals of Vehicle dynamic
CO2	Considerably more in-depth knowledge of suspension, steering system
CO3	Knowledge of vehicle stability.
CO4	Deeper knowledge of vehicle handling
CO5	knowledge of Aerodynamic Drag of Cars

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction:</b> Classification of vibration, definitions, mechanical, vibrating systems, mechanical vibration and human comfort, modeling and simulation studies. Model of an automobile, one degree of freedom, two degree of freedom systems, free, forced and damped vibrations. Magnification and transmissibility. Vibration absorber, multidegree of freedom systems-closed and far coupled systems, Orthogonality of modal shapes, modal analysis.	<b>7 Hrs</b>

<b>Unit 2</b>	<b>Suspension:</b> Requirements, spring mass frequency, wheel hop, wheel shimmy, choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and aft directions. Hydraulic dampers and choice of damper characteristics. Independent, compensated, rubber and air suspension systems. Roll axis and vehicle under the action of side forces.	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Steering systems :</b> Front axle types, constructional details, front wheel geometry, Condition for True rolling, skidding, steering linkages for conventional & independent suspensions, turning radius, wheel wobble and shimmy, power and power assisted steering. <b>Tyres:</b> Types. Relative merits and demerits. Ride characteristics. Behavior while cornering, slip angle, cornering force, power consumed by a tyre. Effect of camber, camber thrust	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Stability of vehicles:</b> Load distribution. Stability on a curved track and on a slope. Gyroscopic effects, weight transfer during acceleration and braking, over turning and sliding. Rigid vehicle-stability and equations of motion. Cross wind handling.	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Vehicle Handling:</b> Over steer, under steer, steady state cornering. Effect of braking, driving torques on steering, effect of camber, transient effects in cornering. Directional stability of vehicles	<b>6 Hrs</b>
<b>Unit 6</b>	<b>Aerodynamic Drag of Cars:</b> Cars as a bluff body, flow field around car, drag force, types of drag force, analysis of aerodynamic drag, drag coefficient of cars, strategies for aerodynamic development, low drag profiles. Scope, historical developments, fundamentals of fluid mechanics, flow phenomenon related to vehicles, external and Internal flow problem, resistance to vehicle motion, performance, fuel consumption and performance potential of vehicle aerodynamics	<b>6 Hrs</b>

### Learning Resources:

#### Text Books

1	Thomas D Gillespie, —Fundamentals of Vehicle dynamics, SAE USA 1992
2	Thomson WT _Theory of Vibration with Applications', CBS Publishers and Distributors, New Delhi. 1990
	Wong J Y, —Theory of Ground Vehicles, John Wiley & Sons, New York, 1978

#### Reference Books

1	Cole D E, —Elementary Vehicle Dynamics, Ann Arbor, Michigan, USA, 1972
2	Maurice Olley, —Chassis Design – Principles and Analysis, Bentley publishers
3	J. G. Giles, _Steering Suspension and Tyres, Illiffe Books Ltd., 1968

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGPEMDE2043 Course Name: Reliability Engineering</b> <b>(Program Elective-V)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To acquire basic understanding of Reliability Engineering.
2	To acquire complete knowledge of Failure data analysis and reliability measures
3	To make students understand and learn about reliability models and Reliability Evaluation of Systems
4	To acquire knowledge of Design for Reliability and Maintainability and reliability Testing.

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Knowledge of Reliability Engineering
CO2	Considerably more in-depth knowledge of Failure data analysis and reliability measures
CO3	Knowledge of Failure data analysis and reliability measures.
CO4	Deeper knowledge of Design for Reliability and Maintainability
CO5	Knowledge of reliability Testing

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction:</b> Brief history, concepts, terms and definitions, applications, the life cycle of a system, concept of failure, typical engineering failures and their causes, theory of probability and reliability, rules of probability, random variables, discrete and continuous probability distributions. <b>Failure Data Analysis:</b> Data collection and empirical methods, estimation of performance measures for ungrouped complete data, grouped complete data, analysis of	<b>7 Hrs</b>

	censored data, fitting probability distributions graphically (Exponential and Weibull) and estimation of distribution parameters.	
<b>Unit 2</b>	<b>Reliability Measures:</b> Reliability function– $R(t)$ , cumulative distribution function (CDF)– $F(t)$ , probability density function (PDF) – $f(t)$ , hazard rate function– $\lambda(t)$ , Mean time to failure (MTTF) and Mean time between failures (MTBF), median time to failure ( $t_{med}$ ), mode ( $t_{mode}$ ), variance ( $\sigma^2$ ) and standard deviation ( $\sigma$ ), typical forms of hazard rate function, bathtub curve and conditional reliability.	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Basic Reliability Models:</b> Constant failure rate (CFR) model, failure modes, renewal and Poisson process, two parameter exponential distribution, redundancy with CFR model, time- dependent failure models, Weibull, Rayleigh, Normal and Lognormal distributions, burn-in screening for Weibull, redundancy, three parameter Weibull, calculation of $R(t)$ , $F(t)$ , $f(t)$ , $\lambda(t)$ , MTTF, $t_{med}$ , $t_{mode}$ , $\sigma^2$ and $\sigma$ for above distributions	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Reliability Evaluation of Systems:</b> Reliability block diagram, series configuration, parallel configuration, mixed configurations, redundant systems, high level versus low level redundancy, k- out-of-n redundancy, complex configurations, network reduction and decomposition methods, cut and tie set approach for reliability evaluation.	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Maintainability and Availability:</b> Concept of maintainability, measures of maintainability, mean time to repair (MTTR), analysis of downtime, repair time distributions, stochastic point processes, maintenance concept and procedures, availability concepts and definitions, important availability measure	<b>6Hrs</b>
<b>Unit 6</b>	<b>Design for Reliability and Maintainability:</b> Reliability design process and design methods, reliability allocation, failure modes, effects and criticality analysis (FMECA), fault tree and success tree methods, symbols used, maintainability design process, quantifiable measures of maintainability, repair versus replacement. <b>Reliability Testing:</b> Product testing, reliability life testing, burn-in testing, acceptance testing, accelerated life testing and reliability growth testing	<b>6Hrs</b>

### Learning Resources:

#### Text Books

1	Charles E. Ebling, 2004, An Introduction to Reliability and Maintainability Engineering, TataMcGraw Hill Education Private Limited, NewDelhi
2	L. S. Srinath, 1991, —Reliability EngineeringI, East West Press, NewDelhi
3	Alessandro Birolini, 2010, —Reliability Engineering: Theory and Practicel, Springer

4	Roy Billiton and Ronald Norman Allan, 1992, —Reliability evaluation of engineering systems:concepts and techniques, Springer
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### Reference Books

1	B. S. Dhillon, Chanan Singh, 1981, Engineering Reliability – New Techniques and Applications, John Wiley and Sons
2	Andrew Kennedy, Skilling Jardine, Albert H. C. Tsang, 2006, —Maintenance, Replacement and Reliability: Theory and Applications, CRC/Taylor and Francis
3	B. S. Dhillon, 1999, —Engineering Maintainability, Prentice Hall of India

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGOEC2051 Course Name: Cryogenics (Open Elective)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	Learn about low temperature applications in engineering
2	Learn to the technology of gas liquefaction, separation and purification.
3	Study of measurement system at low temperature
4	Learn to stored Cryogenic fluids, vacuum system, insulations used

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Introduce the importance of Cryogenics and its various applications in different areas
CO2	Describe various methods to produce low temperature and phenomena's at cryogenic temperature.
CO3	Understand the working principle of different cryogenic refrigeration and liquefaction system.
CO4	Understand cryogenic equipment's and plants.
CO5	Demonstrate the knowledge of cryogenic instrumentation

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction and Properties of materials at low temperature:</b> Meaning & definition of cryogenics, Importance of cryogenics studies, properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric & magnetic properties, super conducting materials, thermo electric materials, composite materials.	<b>7 Hrs</b>
<b>Unit 2</b>	<b>Liquefaction of Cryogenic Gases:</b> Ideal cycle, system performance parameters, Joule Thomson effect, adiabatic expansion, liquefaction systems; Simple Linde Hampson system, Precooled Linde Hampson system, Cascade	<b>7 Hrs</b>

	system, Claude system, comparison of above systems. Claude system for liquefaction of hydrogen and neon	
<b>Unit 3</b>	<b>Cryocoolers:</b> Ideal refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvay refrigerator, Gifford McMohan refrigerator, Pulse tube refrigerator.	<b>7 Hrs</b>
<b>Unit 4</b>	<b>Cryogenic Plants and Equipment's:</b> Air separation and purification system linde single column and double column system Dewars, classification of Dewar's, Inner vessel design, Suspension system design, Piping Insulations used in Cryogenics, Importance of Vacuum system in Cryogenics, Vacuum System, Vacuum Pumps , Vacuum Valves	<b>7 Hrs</b>
<b>Unit 5</b>	<b>Cryogenic Measurement systems:</b> Temperature measurements, pressure measurements, flow measurements, liquid level measurements, fluid quality measurements.	<b>6 Hrs</b>
<b>Unit 6</b>	<b>Applications of Cryogenics:</b> Superconductive devices: Superconducting bearings, magnets, motors gyroscope and switches, Cryotrons and MRI Manufacturing process application Medical Application: cryosurgery, skin disease treatment Space applications: Missile launching, propellant pressurizing systems, vehicle cooling, cryopropellants, space simulators Electronic applications: MASER, LASER, infrared detectors, hotomultipliers	<b>6 Hrs</b>

### Learning Resources:

#### Text Books

1	Cryogenics, S.S. Thipase, Narosa Book Distributors Pvt Ltd (1 January 2012)
2	Fundamentals of cryogenic engineering, MamataMukhopadhyay, Prentice Hall India Learning Private Limited; 4th edition (1 January 2010)
	Cryogenic Technology and Applications, A.R. Jha, Elsevier Science

#### Reference Books

1	Barron F. Randall, —Cryogenic Systems   Oxford University Press, New York2. Cryogenic fundamentals- Haselden, Academic press New York
2	Cryogenic engineering, Thomas Flynn, CRC Press; 2nd edition (June 30, 2020)
3	Cryogenic Engineering & Gas Applications, Dr. P.K. Bose.

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGOEC2052 Course Name: Design for Manufacture &amp; Assembly (Open Elective)</b>		
Teaching Scheme	Credit	Evaluation Scheme
Lectures: 03 Hours/Week	03	ISE: 40 Marks ESE: 60 Marks

**Course Objectives:** The objective of the course is to

1	To understand how to apply tolerances, limits fits
2	To understand form design of casting, weldments, forging and sheet metal components.
3	To understand component design and how to apply DFMA Tools
4	To reduce production costs by analyzing and eliminating the factors that greatly affect the time, cost, and quality of manufacturing, assembly and service processes
5	To apply design for the environment

**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Students get knowledge of how to apply tolerances, limits fits.
CO2	Students get knowledge of form design of casting, weldments, forging and sheet metal components.
CO3	Students get knowledge of component design and how to apply DFMA Tools.
CO4	Students get knowledge of design for the environment.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	<b>Introduction to tolerances:</b> Tolerances: Limits and Fits, tolerance Chains and identification of functionally important dimensions. Dimensional chain analysis-equivalent tolerances method, equivalent standard tolerance grade method, equivalent influence method. Geometric tolerances: applications, geometric tolerancing for manufacture as per Indian Standards and ASME Y 14.5 standard, surface finish, review of relationship between attainable tolerance grades and different machining	<b>7 Hrs</b>

<b>Unit 2</b>	<b>Form design of castings, weldments`, forging and sheet metal components:</b> Materials choice - Influences of materials - Space factor - Size - Weight - Surface properties and production method on form design. Redesign of castings based on parting line considerations, Minimizing core requirements, redesigning cast members using Weldments, form design aspects in Forging and sheet metal components.	<b>7 Hrs</b>
<b>Unit 3</b>	<b>Component Design:</b> Machining Considerations Design features to facilitate machining - Drills - Milling cutters - Keyways – Doweling procedures, Counter sunk screws - Reduction of machined area- Simplification by separation – Simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly. Redesign For Manufacture - Design features to facilitate machining: datum features - functional and manufacturing. Component design – machining considerations, redesign for manufacture, examples	<b>7 Hrs</b>
<b>Unit 4</b>	<b>DFMA TOOLS :</b> Rules and methodologies used to design components for manual, automatic and flexible assembly,traditional design and manufacture Vs concurrent engineering, DFA index, poke- yoke, lean principles, six sigma concepts, DFMA as the tool for concurrent engineering, three DFMA criteria for retaining components for redesign of a product; design for manual assembly; design for automatic assembly; computer-aided design for assembly using software	<b>7 Hrs</b>
<b>Unit 5</b>	<b>DESIGN FOR THE ENVIRONMENT</b> Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&T’s environmentally responsible	<b>6 Hrs</b>
<b>Unit 6</b>	<b>Product assessment</b> – Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for Recyclability – Design for remanufacture –Design for energy efficiency – Design to regulations and standards.	<b>6 Hrs</b>

### Learning Resources:

#### Text Books

1	A.K. Chitale and R. C. Gupta, Product Design and Manufacturing, PHI2007.
2	G.Boothroyd, P.Dewhurst and W.Knight, Product Design for Manufacture andAssembly, Marcell Dekker, 2002.
	R.Bryan , Fischer, Mechanical Tolerance stackup and analysis, Marcell Dekker,2004.

**Reference Books**

1	M. F. Spotts, Dimensioning and Tolerance for Quantity Production, Prentice Hall Inc.,1999.
2	J.G. Bralla, Hand Book of Product Design for Manufacturing, McGraw Hill Publications,2000.
3	G.E. Dieter ,Engineering Design: A Materials and Processing Approach. McGraw-Hill

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGLCMDE206 Course Name: Computer Aided Analysis Lab</b>		
Teaching Scheme	Credit	Evaluation Scheme
Practical : 02 Hours/Week	01	ISA: 25 Marks

**Course Objectives:** The objective of the course is to

1	To make students understand and learn about the analysis and simulation of mechanical parts through software and the solving techniques of various engineering problems
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**Course Outcomes:**

<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Gain knowledge of importing geometry in FEA software
CO2	Learn ANSYS- Analysis Software/Any analysis software
CO3	Be able to use the ANSYS software/Any open source analysis software for solving various problems

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	Importing Geometry in FEA Software	<b>4 Hrs</b>
<b>Unit 2</b>	Static Analysis of a Truss	<b>4 Hrs</b>
<b>Unit 3</b>	Static Analysis of a Beam	<b>4 Hrs</b>
<b>Unit 4</b>	Torsional Analysis of a Shaft	<b>4 Hrs</b>
<b>Unit 5</b>	3 Dimensional FE Analysis of ONE of the following using FEA software. a) Gear tooth analysis b) Crane Hook analysis	<b>8 Hrs</b>
<b>Unit 6</b>	At least one project and a case study should be carried out based on recent Publications / Research papers / Technical development.	<b>4 Hrs</b>

**Learning Resources:****Text Books**

1	Rao S. S. —Finite Elements Method in Engineering— 4th Edition, Elsevier,2006
2	Frank L. Stasa, Applied finite Element Analysis for Engineers, CBS International Edition, 1985.
3	Bathe K. J. Finite Elements Procedures, PHI.
4	Cook R. D., et al. —Concepts and Application of Finite Elements Analysis— 4th Edition, Wiley & Sons, 2003.

**Reference Books**

1	Zeinkovich, —The Finite Element Method for Solid and Structural Mechanics, 6 <sup>th</sup> Ed., Elsevier2007.
2	Desai C.S and Abel, J.F., Introduction to the finite element Method, Affiliated Eastwest Press Pvt. Ltd. New Delhi, 2000.

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGSWMDE207T Course Name: SEMINAR-II</b>		
Teaching Scheme	Credit	Evaluation Scheme
Practical : 02 Hours/Week	01	ISA: 50 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To Identify, understand and discuss current, real-world issues.
2	To Distinguish and integrate differing forms of knowledge and academic disciplinary approaches (e.g., humanities and sciences) with that of the student's own academic discipline (e.g., in agriculture, architecture, art, business, economics, education, engineering, natural resources, etc.). And apply a multidisciplinary strategy to address current, real-world issues.
3	To Improve oral and written communication skills.
4	To Improve presentation skills
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Apply principles of ethical leadership, collaborative engagement, socially responsible behavior, respect for diversity in an interdependent world, and a service-oriented commitment to advance and sustain local and global communities.
CO2	Learn and integrate. Through independent learning and collaborative study, attain, use, and develop knowledge in the arts, humanities, sciences, and social sciences, with disciplinary specialization and the ability to integrate information across disciplines.
CO3	Think and create. Use multiple thinking strategies to examine real-world issues, explore creative avenues of expression, solve problems, and make consequential decisions
CO4	Communicate. Acquire, articulate, create and convey intended meaning using verbal and non-verbal method of communication that demonstrates respect and understanding in a complex society.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	Seminar II shall be based on tentative topic of dissertation such as review paper on some specific well defined area/ specialized stream of Mechanical Engineering. 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 faculty, 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	<b>7 Hrs</b>

<b>Tatyasaheb Kore Institute of Engineering and Technology, Warananagar</b> First Year M. Tech. Department of Mechanical Engineering (Design Engineering)		
<b>Course Code: 2501PGSMDE208P Course Name: Comprehensive Viva</b>		
Teaching Scheme	Credit	Evaluation Scheme
Practical : 02 Hours/Week	01	OE: 25 Marks

<b>Course Objectives:</b> The objective of the course is to	
1	To verify the continuous assessment and performance of students by external examiner and internal examiner.
<b>Course Outcomes:</b>	
<b>Co's</b>	At the end of successful completion of the course, the student will be able to
CO1	Verify their knowledge based on the subjects they have studied in Semester-I and Semester-II.

<b>Unit No.</b>	<b>Course Contents</b>	<b>Hours</b>
<b>Unit 1</b>	The students have to prepare on all subjects which they have studied in I <sup>st</sup> and II <sup>nd</sup> semesters The viva will be conducted by the External/Internal Examiner jointly and their appointments will be made by institute. The in-depth knowledge, preparation and subjects understanding will be assessed by the Examiners.	<b>-- Hrs</b>