An Autonomous Programme Structure of

M. Tech. Mechanical Engineering

Specialization: Mechanical Engineering Design

(With Effect From Academic Year: 2017-2018)

SEMESTER I

Course Code	Course Title	Teaching Scheme Hours/Week			Examination Scheme				Marks	Credit
		Lecture	Tutorial	Practical	In Semester	End Semester	Oral	Practical		
MED 1101	Advanced Mathematics and Numerical Techniques	3	1	0	50	50	0	0	100	4
MED 1102	Design of Experiments and Research Methodology	3	1	0	50	50	0	0	100	4
MED 1103	Advance Mechanics of Materials	3	0	0	50	50	0	0	100	3
MED 1104	Design of Tribosystems	3	0	0	50	50	0	0	100	3
PEMED 1101	Elective I	3	0	0	50	50	0	0	100	3
MED 1105	Design of Tribosystems Lab	0	0	2	0	0	25	0	25	1
MED 1106	Advance Mechanics of Materials Lab	0	0	2	0	0	0	25	25	1
PEMED 1102	Elective I Lab	0	0	2	0	0	25	0	25	1
Total		**15**	**2**	**6**	**250**	**250**	**50**	**25**	**575**	**20**
Grand Total		**23**			**575**				**575**	**20**

Elective I:

1. Transport Phenomena
2. Advance Materials Technology
3. Power Train design

SEMESTER II

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Marks	Credit
		Lecture	Tutorial	Practical	In Semester	End Semester	Oral	Practical		
MED 1201	Automation and Control Technology	3	0	0	50	50	0	0	100	3
MED 1202	Vibration and Acoustic	3	0	0	50	50	0	0	100	3
MED 1203	Finite Element Analysis	3	0	0	50	50	0	0	100	3
MED 1204	Design & Optimization	3	0	0	50	50	0	0	100	3
PEMED 1202	Elective II	3	0	0	50	50	0	0	100	3
MED 1105	Automation and Control Technology Lab	0	0	2	0	0	25	0	25	1
MED 1106	Vibration and Acoustic Lab	0	0	2	0	0	25	0	25	1
MED 1107	Finite Element Analysis Lab	0	0	2	0	0	0	25	25	1
MED 1108	Seminar	0	2	0	0	0	50	0	50	2
AC 1201	Audit Course*	0	0	2	0	0	0	0	0	0
Total		**15**	**2**	**8**	**250**	**250**	**100**	**25**	**625**	**20**
Grand Total		**25**			**625**				**625**	**20**

Elective II:

1. Computational Fluid Dynamics
2. Design for Manufacture and Assembly
3. Heat Exchanger Design

AC 1201: *Audit Courses – Soft Skills and Business Communication / Entrepreneurship Development

SEMESTER III

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme			Marks	Credit
		Lecture	Tutorial	Practical	In Semester	End Semester	Oral		
HSEL 2101	Elective III	3	1	0	50	50	0	100	4
OE 2101	Elective IV	3	0	0	50	50	0	100	3
MED 2104	Project Stage I	0	0	18	125	0	100	225	9
Total		**6**	**1**	**18**	**225**	**100**	**100**	**425**	**16**
Grand Total		**25**			**425**			**425**	**16**

Elective III:

1. Environmental Studies
2. Engineering Economics and Project Management
3. Fundamentals of Disaster Management

Elective IV:

1. Modal Analysis
2. Vehicle Dynamics
3. Reliability-Base Design Optimization

SEMESTER IV

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme			Marks	Credit
		Lecture	Tutorial	Practical	In Semester	End Semester	Oral		
MED 1202	Project Stage II	0	0	28	200	0	150	350	14
Total		**0**	**0**	**28**	**200**	**0**	**150**	**350**	**14**
Grand Total		**28**			**350**			**350**	**14**

MED 1101 Advanced Mathematics and Numerical Techniques

Teaching Scheme
Lecture: 3 Hrs/week
Tutorials: 1 Hr/week

Examination Scheme
In semester: 25 marks
End semester: 50 marks
Credits: 4

Unit 1: Linear Algebra **8 Hrs**

Matrices and systems of linear equations; Solution of **Ax = b** (Gauss elimination/ Gauss-Jordan elimination, Rank of matrix); Vectors in n-dimensions; Linear dependence and independence of vectors; Matrix Arithmetic; Inverse of a matrix; Jacobi and Gauss-Seidel Iterative Methods; LU decomposition; Cholesky Method; Determinants of square matrices, minors and cofactors; Adjoint of a matrix; Norm and inner product of vectors; Orthogonal vectors and matrices; Eigenvalues; Diagonalization and Quadratic forms.

Unit 2: Ordinary Differential Equations: **7 Hrs**

Introduction, Classification of ODE's, Linear differential equations of n-th order with constant coefficients (homogeneous and non-homogeneous), Solutions of systems of linear differential equations (homogeneous and non-homogeneous); Initial Value Problem -- Solution Concept, Euler's Method, Modified Euler's Method, Heun's Method, First, second, third and fourth order Runge-Kutta methods, Predictor-corrector method; Boundary Value Problem – Solution Concept for second order equation using Finite Difference Methods.

Unit 3: Partial Differential Equations: **6 Hrs**

Introduction and classification of linear partial differential equations of second order (Parabolic, Elliptic and Hyperbolic), Solutions for homogeneous forms for a variety of boundary conditions using Finite Difference Methods -- Elliptic and Parabolic equations.

Unit 4: Transforms: **6 Hrs**

Concept of transforms, Fourier transforms, Applications to partial differential equations, Laplace transforms and its inverse, Laplace transform of special functions: Unit step, Unit impulse, Periodic and Error. Applications to initial value problem and wave equation using transform techniques.

Unit 5: Numerical Differentiation and Integration **6 Hrs**

Numerical Differentiation: Definition of derivatives, Engineering applications, basic finite difference method, Taylor's series expansion, Difference operators, Differentiation of interpolating polynomials
Numerical Integration: Engineering Applications, Newton Cotes formulae, Simpson's, Richardson's extrapolation, Romberg integration, Gauss Quadrature for double and triple integration, Integration in two and three dimensional domains

Unit 6: Introduction to Optimization **5 Hrs**

Engineering applications of optimization, statement of optimization problem, classification of optimization problems, single variable optimization multivariable optimization without constraints, Modern Methods of Optimization- GA, SA, PSO, ANN etc.

Books:

1. S.S.Rao, *Applied Numerical Methods for Engineers and Scientists,* Prentice Hall, 2002
2. Steven C. Chapra, *Applied Numerical Methods with MATLAB for Engineers and Scientists,* TATA McGRAW-HILL, 3rd Edition, 2012
3. Erwin Kreyszig, *Advanced Engineering Mathematics*, Wiley Eastern Ltd., 10th Edition, 2004.
4. Peter V. O' Neil, *Advanced Engineering Mathematics*, Thomson Brooks Cole, Singapore,5th edition

MED 1102 Design of Experiments and Research Methodology

Teaching Scheme
Lecture: 3 Hrs/week
Tutorial: 1 Hrs/week

Examination Scheme
In semester: 50 marks
End semester: 50 marks
Credits: 3

Prerequisite: Technical Seminar, Mini/Minor Project and Major/Final year B.E./BTech. projects.

Course Objectives:
Students are expected to –

1. Understand Phases of Research, Types of Research,
2. Understand concept and application of Research Methodologies and Statistical Techniques used in research.
3. Understand concept and application of System Engineering
4. Understand of the key elements of Systems Engineering
5. Understand systems engineering processes, requirements analysis, interface definition and management, system models, and design validation techniques

Course Outcome:

1. Students will be capable to do critical literature review and formulate the research problem.
2. Students will be capable to do select appropriate Research Method(s) and Statistical Techniques used in research.
3. Students will be able to describe the major activities of the systems engineering process.
4. Students will be able to apply the system engineering

Course Description: To be in the Handouts
Distribution of Marks (Table in %) to be in the Handouts for Tutorials

Unit 1: Research Problem definition and research methodologies 6

- Introduction to research: Definitions and characteristics of research; Types of research; Main components of any research work. Scope and objectives of research problem. Criteria / Characteristics of a good research problem, Errors in selecting a research problem.
- Literature review and Problem identification: Purpose of literature review; Source of information; Organization of information, Identifying gap areas from literature review and formulating the problem statement.
- Research design and Work Plan: – Research design – Basic Principles- Need of research design Features of good design – Important concepts relating to research design; Work Plan
- Writing a research report: Format of research proposal, Individual research proposal, Institutional proposal, Proposal of a student.

Unit 2: Introduction to Mathematical Modeling and Design of Experiment 6

- Mathematical Modeling : Introduction, Modeling methods, examples from engineering
- Design of Experiment : Introduction to: Full Factorial Method Taguchi DoE, Response Surface Method

Unit 3: Data Collection, Analysis and Applied Statistics **6**

Study of: Population; Variables; Sampling; Sample size determination; Plan for data collection; Methods of data collection; Plan for data processing and analysis; Ethical considerations.
Co-relation analysis, Regression analysis, Parameter estimation, Multivariate statistics.

Unit 4: Systems Engineering in New Product Development **6**

- What is SE? - Origin and evolution - Definitions of systems - Need of Systems Engineering - Objectives of SE –Importance - Relation of SE to architecture
- Introduction to the Systems Engineering Process - SE relationship to the generic Product Development (PD) Process – Systems Engineering & Program Management

Unit 5: Requirements Development and Management **7**

- Requirement Development Process - Requirement Elicitation - Sources of Requirements
- Quality Functional Deployment (QFD)
- Requirements Attributes – Rationale - Conditions of operation – How to write good requirements – Requirement Validation
- Boundary diagrams - Interface definition and management - Managing changes to Requirements

Unit 6: System Design, Analysis, Verification and Validation **7**

- Concept Selection - Managing System Interactions – Design Structure Matrix (DSM) - System Architecture - System integration – Design for X - Design Optimization - Design reviews
- Risk/uncertainty management – Design Failure Modes and Effects Analysis (DFMEA) - Technical Performance Measure (TPM) – Critical Parameter Management (CPM)
- Verifying process capability - Design verification and validation plan – Execution – Interpretation - Reliability

Text Books:

1. Research methodology: an introduction for science & engineering students', by Stuart Melville and Wayne Goddard
2. 'Research Methodology: A Step by Step Guide for Beginners', by Ranjit Kumar, 2nd Edition
3. 'Research Methodology: Methods and Trends', by Dr. C. R. Kothari.
4. Systems Engineering Principles and Practice, 2nd Edition, A. Kossiakoff, W. Sweet, and S. Biemer, Wiley Series in Systems Engineering and Management, Wiley Interscience, 2011.

References:

1. Creswell, J. W. Research design: Qualitative, quantitative and mixed methods approaches. 4th Ed. Thousand Oaks, CA: Sage, 2014.
2. 'Research Methodology: An Introduction' by Wayne Goddard and Stuart Melville
3. System Engineering Management, Benjamin Blanchard, Wiley & Sons, Inc., 2008
4. The Engineering Design of Systems: Models and Methods, Dennis M. Buede, John Wiley & Sons, Inc., 2000.
5. Customer – Centered Products, Amacom, IvyF Hooks and Kristin A Farry

6. Systems Engineering Handbook: A 'What to' Guide for All SE Practitioners, INCOSE-TP-2003-016-02, Version 2a, 1 June 2004 http://www.incose.org/ProductsPublications/sehandbook.

Lab Practice

Research Methodology

RM1: Select any suitable technical topic, complete detail literature study and prepare literature review report/paper.

RM2: Select any suitable subject / research topic and write a research proposal in the standard/given format.

RM3: Select any suitable subject / research work and write the invention/innovation in the format of patent filing format (viz. Form no. 1 & Form no. 2)

System Engineering

SE1: Consider you are a systems engineer of a XYZ project understand stakeholders needs and develop 'eight' good quality requirement statements.

SE2: Case study based assignment to analyse the use of systems engineering practices to solve the problems.

- **The textbook for "Design and Analysis of Experiments" course is…**

1 Dean, Angela M., and Daniel Voss. 2000. Design and Analysis of Experiments. Corrected. Springer.
The text has a website where you can obtain datasets for various examples and homework problems.
http://www.wright.edu/ dan.voss/book/DeanVoss.html
Under the 'Data' page. Import the '.txt' version of the file unless you have configured your software to import SAS files.

- **Additional references are:**

2 Box, George E. P., J. Stuart Hunter, and William G. Hunter. 2005. Statistics for Experimenters: Design, Innovation, and Discovery, 2nd Edition.
2nd ed. Wiley-Interscience. Includes material on implementations in R.

3 Vikneswaran (2005). An R companion to "Experimental Design". URL
http://cran.r-project.org/doc/contrib/Vikneswaran-EDcompanion.pdf.
A companion to another textbook on Experimental Design that has examples of various DoE methods performed in R.

4 Montero (2002) Introduction to Design of Experiments Part 3: Software.
URL http://www.ces.clemson.edu/courses/me323/labs/softorthog.pdf
A presentation that steps through using MINITAB to perform various tasks in DoE.

5 NIST Engineering Statistics Handbook Section 5.3 Choosing an experimental design

http://www.itl.nist.gov/div898/handbook/pri/section3/pri3.htm and
Section 5.4 Analysis of DoE data
http://www.itl.nist.gov/div898/handbook/pri/section4/pri4.htm

The National Institute of Science and Technology (NIST) handbook on statistics, which provides an overview of topics within DoE.

6 CRAN Task View: Design of Experiments.
http://cran.r-project.org/web/views/ExperimentalDesign.html

MED 1103 Advance Mechanics of Materials

Teaching Scheme
Lecture: 3 Hrs/week
Tutorials: 0 Hr/week

Examination Scheme
In semester: 50 marks
End semester: 50 marks
Credits: 3

Prerequisites

Applied Mechanics, Strength of Materials, Engineering Materials

Course Objectives

Introduce students to

1. basics of theory of elasticity
2. basics of theory of plasticity
3. fracture mechanics and fatigue behavior of material
4. nature and behavior of composite materials

Course Outcomes

Students will be able to

1. solve the problems on theory of elasticity and plasticity
2. understand the fracture mechanics and fatigue failure of the material
3. understand the composite material and its failure criteria
4. test different physical and mechanical properties of the material

Unit 1 Theory of Elasticity **10 Hrs**

Analysis of stress and strain, Stress–Strain Relations for Linearly Elastic Solids, Yield Criteria and Introduction to ideally Plastic Solid.

Unit 2 Theory of Plasticity **10 Hrs**

Non-linear material response, Yield criteria: maximum principal stress criteria, maximum principal strain criteria, strain-energy density criteria, alternative yield criteria, general yielding.

Unit 3 Introduction to fatigue and fracture mechanics **10 Hrs**

Stress life: S-N diagram, Mean stress effect, modifying factors, Strain-life: material behavior, strain-life curve, fatigue properties, mean stress effect, Brittle Fracture, Stress Intensity Factor, Fracture Toughness, Fracture Conditions, Fracture Modes, Plane Stress and Plane Strain, Plastic Collapse at a Notch, Experimental Determination of K_Ic, Strain-Energy Release Rate, Meaning of Energy Criterion, Design Consideration.

Unit 4 Mechanics of Composite Materials **10 Hrs**

Stress–Strain Relations, Basic Cases of Elastic Symmetry, Laminates, Ply Stress and Ply Strain, Failure Criteria of Composite Materials, Micromechanics of Composites

References

1. Advanced Mechanics of Solids, L. S. Srinath, Tata McGraw-Hill
2. Advanced Mechanics of Materials, A. P. Boresi, Wiley
3. Theory of Elasticity, S. P. Timoshenko, Mc Graw Hill
4. Fundamentals of metal Fatigue, J. A. Bannantine, Prentice Hall
5. Mechanics of Composite Materials, A. K. Kaw, CRC Press

MED 1104 Design of Tribosystems

Teaching Scheme
Lecture: 3 Hrs/week
Tutorials: 0 Hr/week

Examination Scheme
In semester: 50 marks
End semester: 50 marks
Credits: 3

Unit 1: **20 Hrs**

Application of system concepts to tribology, Function of Tribomechanical systems, Structure of Tribo-mechanical systems, Tribological interaction, Functional plane, mechanical work plane, thermal plane and material plane. Role of tribo processes in mechanical systems, Wear as a system property. Contact Mechanics, number of bodies taking part in contact process, macro geometry of bodies, Deformation mode; elastic , plastic and elastic-plastic, Types of relative motion; static contact, rolling contact, sliding contact, contact physics and geometry, contamination layer, absorbed gas layer, oxide layer, work hardened layer, metal substrate.

Unit 2: **10 Hrs**

Materials for various tribo-components, materials for plane bearing, materials for gear, materials for brakes, clutches, materials for Internal combustion engines, ceramics and special alloys, cermets, polymer materials, selection considerations in design.

Unit 3: **10 Hrs**

Design of various tribo-elements; such as: Plane bearing, Gear, Seals, Piston and cylinder, Friction devices, cutting tools, chains. Design of lubrication systems.

Text Book:

1. Czichos, H., "Tribology: A system approach to the science & technology of friction, lubrication and wear,"– Tribology Series 1, Elsevier Scientific Publishing Company, Amsterdam, Netherland, 1978.

Reference Books:

1. Peterson, M. B., Winer, W. O., "Wear Control Handbook," ASME, N. Y., 1992.
2. Glaeser, W. A., "Tribology: Materials for Tribology," –Tribology series – Vol. 20, Elsevier,N. Y. 1992.
3. Stolarski, T., "Tribology in Machine Design", Butterworth-Heinemann, N. Y., 1990

PEMED 1101A Transport Phenomena

Teaching Scheme
Lecture: 3 Hrs/week
Practical: 0 Hr/week

Examination Scheme
In semester: 50 marks
End semester: 50 marks
Credits: 3

Unit 1: **3 Hrs**
Introduction to transport phenomena, momentum transfer, heat transfer and mass transfer.

Unit 2: **10 Hrs**
Description of fluid flow motion, conservation of mass, momentum equation, energy equation (Integral and differential approach)

Unit 3: **8 Hrs**
Inviscid and viscous fluid flow, boundary layers

Unit 4: **8 Hrs**
Differential equation of heat transfer, steady state conduction, convective heat transfer and radiation heat transfer

Unit 5: **5 Hrs**
Fundamentals of mass transfer, differential equation of mass transfer, steady state mass diffusion, convective mass transfer

Unit 6: **5 Hrs**
Applications: Fluid machinery, heat and mass transfer equipments

Books:

1. Welty, J. R., C. E. Wicks, R. E. Wilson, and G. Rorrer. Fundamentals of Momentum, Heat, and Mass Transfer. 4th ed. New York, NY: John Wiley & Sons, 2000. ISBN: 9780471381495.

2. Bird, R. Byron, Warren E. Stewart, and Edwin N. Lightfoot. Transport Phenomena. New York, NY: John Wiley & Sons, 1960. Also 2nd ed. 2001. ISBN: 9780471410775.

3. Incropera, Frank P., and David P. DeWitt. Fundamentals of Heat and Mass Transfer. 5th ed. New York, NY: John Wiley & Sons, 2001. ISBN: 9780471386506.

4. Cussler, E. L. Diffusion: Mass Transfer in Fluid Systems. 2nd ed. Cambridge, UK: Cambridge University Press, 1997. ISBN: 9780521564779.

5. Holman, J. P. Heat Transfer. 8th ed. New York, NY: McGraw-Hill, 1996. ISBN: 9780078447853.

MED 1105 Design of Tribosystems Lab

Teaching Scheme
Lecture: 0 Hrs/week
Practical: 2 Hr/week

Examination Scheme
In semester: 0 marks
End semester: 0 marks
Oral/Practical: 25 marks
Credits: 1

List of Experiments: (Any 5)

1. Determine the coefficient of friction for different conditions and different material pairs.
2. Assess rolling type abrasion resisting life for various types of industrial materials
3. Experiments on wear measurement.
4. Study effect of lubricants and their properties on friction and wear.
5. Study effect of additives on lubricant performance.
6. Experiment on gas lubricated bearing.
7. Experimental study on Journal bearing performance.

Assignment:

Design of **Any one** tribo-element; such as: Plane bearing, Gear, Seals, Piston and cylinder

MED 1106 Advance Mechanics of Materials Lab

Teaching Scheme
Lecture: 0 Hrs/week
Practical: 2 Hr/week

Examination Scheme
In semester: 0 marks
End semester: 25 marks
Credits: 1

Assignments

1. Testing of Fracture toughness of Single Edge Notch Bend specimen.
2. Fatigue life estimation of the test specimen.
3. Physical properties of polymer matrix composites.
4. Testing of Mechanical properties of polymer matrix composite (Tensile/Flexural/Impact).
5. FEA of machine member by using commercial software for stress distribution, stress concentration.

PEMED 1102A Transport Phenomena Lab

Teaching Scheme
Lecture: 0 Hrs/week
Practical: 2 Hr/week

Examination Scheme
In semester: 0 marks
End semester: 25 marks
Credits: 1

List of Practicals:

1. Laminar Flow through a pipe: Verification of experimental results with a computational tool
2. Conduction heat transfer**:** Verification of experimental results with a computational tool
3. Convective heat transfer: Comparison of analytical solution using non-dimensional numbers and experimental results
4. Radiation Heat Transfer
5. Demonstration of mass diffusion
6. Numerical code on fluid flow and heat transfer