DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA, RANCHI
Courses of Studies for M.E. Programme in Design of Mechanical Equipments

			L	T	P	C
I Semester						
(Theory courses)						
MME	1051	Advanced Strength of Materials	3	-	-	3
MME	1053	Dynamics of Machines	3	-	-	3
MMA	1103	Advanced Mathematics	3	1	-	4
Elective- any one			3	-	-	3
MME	1061	Optimisation Methods in Engineering				
MME	1063	MATLAB: An Introduction with Application				
MME	1065	Advanced Computer Graphics				
Breadth Subject (any one)			**3**			**3**
Sessional:						
MME	1052	Elective Course work	-	-	2	2
MME	1054	Dynamics of Machine Laboratory	-	-	2	2
		Total	**15**	**1**	**4**	**20**
II Semester:						
(Theory courses)						
MME	2071	Advanced Mechanical Engineering Design	3	-	-	3
MME	2073	Computer Aided Design of Mechanical System	3	-	-	3
MME	2075	Engineering Design Methodology	3	1	-	4
Elective – any one			**3**	**-**	**-**	**3**
MME	2083	Mechanics of Robotic Manipulator				
MME	2085	Reverse Engineering & Rapid Prototyping				
MME	2087	Mechanical Vibrations				
Breadth Subject (any one)			**3**	**-**	**-**	**3**
Sessional:						
MME	2072	Advanced Mechanical Engineering Desig course work	-	-	2	2
MME	2074	CAD Lab	-	-	2	2
			Total :			**20.0**
III Semester:		**Thesis**				**15**
IV Semester:		**Thesis**				**20**
Grand Total						**75**

MME 1051 Advanced Strength of Materials

Module 1
Review of stress, strain, stress Ellipsoid, Mohr's circle for stress in three dimensions. (5L)

Module 2
Theory of Elastic Stability: Euler's column formula with various end conditions, Column with initial eccentricity and eccentric loads, Column with load through a fixed point. Effect of shear force on critical load. (5L)

Module 3
Theory of Elastic Stability: Buckling of columns by energy method, approximate calculation of critical load by energy method, Buckling of rings and circular tubes, , Buckling of rectangular plate uniformly compressed in one direction (5L)

Module 4
Theory of Plates: Bending of long rectangular plates to a cylindrical surface with different boundary conditions. Effect on stresses and deflection by small displacements of longitudinal edges in the plane of plate. (5L)

Module 5
Theory of Plates: Pure bending of plates, Principle curvatures, Relations between bending moment and curvatures, Bending of plates by distributed lateral loads, Combined bending and tension or compression of plates, Strain energy in buckling of plates. (5L)
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Module 6
Theory of Shells: Deformation of shells without and with bending, Membrane theory, Symmetrical buckling of cylindrical shell under the action of uniform axial compression.(5L)

Module 7
Computer Implementation Aspects for Simple 1D and 2D Problems. (5L)

Text Books:

1. Structural stability of columns and plates by N. G. R. Iyengar
2. Fundamentals of structural stability by :George J. Simitses
3. Theory of Elastic stability by S. Timoshenko & G. H. Gere.

MME 1053: Dynamics of Machines

Module 1:
Free undamped longitudinal, transverse and torsional vibration of system having single degree of freedom, two degrees of freedom and multi degrees of freedom. (5L)

Module 2:
Vibrations of geared system, Free damped vibration, Forced vibration with periodic excitation, vibration isolation and transmissibility. (5L)

Module 3:
Inertia force determination and analysis of forces of reciprocating engine mechanism and four bar mechanism. (5L)

Module 4:
Turning moment diagrams for engines, Fluctuation of the crank shaft speed and method to limit the fluctuation. (5L)

Module 5:
Balancing of reciprocating masses, Partial and complete balance, Primary and secondary balance of multi cylinder in-line engines, in-line engines with identical reciprocating parts. (5L)

Module 6:
Balancing of radial engines, Dynamic balancing machine Cam profile determination for any given motion of the follower. (5L)

Module 7:
Dynamics of high speed cam systems, Analysis of cams of specified contours. Cam applications. (5L)

Text Books:

1. Theory of Vibrations with Applications – W. T. Thomson
2. Theory of Mechanical vibration – K.N. Tong
3. Dynamic Balancing of Rotating Machinery by Wilcon
4. Cams by Harold and Rothbart
5. Theory of Machines by Thomas Beven.

MME 1061:OPTIMIZATION METHOD IN ENGINEERING

Introduction to Optimum design of Mechanical Systems. Need of optimization of preliminary design by identification of design requirements and by use of appropriate design strategy. Introduction to detail design optimization by simulation, prototyping and optimum selection of configuration, materials and processes.

Mechanical System Design problem – economic political environment, issues of human safety and welfare, and professional ethics.

Optimum mechanical design concepts. Overview and application of optimization methods to machine elements and mechanical system design. Prototyping, simulation, and use of standards for detail design optimization. Optimum selection of material and proceses in mechanical design using material selection charts and optimization.

Books:

1. S. S. Rao, Optimization: *Theory and Applications*, 2nd ed. Wiley Eastern.
2. K. Deb, *Optimization for Engineering Design-Algorithms and Examples*, Prentice-Hall India.
3. J. S. Arora, *Introduction to Optimum Design*, MCGraw-Hill.
4. G. V. Reklaitis, A. Ravindran and K. M. Ragsdell, *Engineering Optimization-Methods and Applications*, Wiley.
5. R. L. Fox, *Optimization Methods for Engineering Design*, Addison Wesley.

MME 1063: MATLAB: An Introduction with Applications

Module 1:
Matlab Basics (5L)

Module 2:
Numerical Methods (5L)

Module 3:
Optimizations (5L)

Module 4:
Direct Numerical Integration Methods Methods (5L)

Module 5:
Engineering Mechanics (5L)

Module 6:
Mechanical Vibrations (5L)

Module 7:
Variational Principles, Hamilton's Princples (5L)

Text Books:

1. R. V. Dukkipati , MATLAB: An Introdution with Applications, New age int Publ.
2. Chapman, S.J., MATLAB Programming for Engineers, 2nd ed.,
3. Chapra, S.C., Applied Numerical Methods with MATLAB, 2nd ed., McGraw-Hill, Pratap, Rudra, Getting started with MATLAB—A Quick Introduction for Scientists and Engineers,

MME 2071: ADVANCED MECHANICAL ENGINEERING DESIGN

Module 1:
Introduction: Introduction to Advanced Mechanical Engineering Design. Review of materials and processes for machine elements. (5L)

Module 2:
Strength and Failure Theories: Review of static strength failure analysis, theories of failure including von-Mises theory based strength design. (5L)

Module 3:
Design for Fatigue, Creep and Surface Failure: High cycle and low cycle fatigue. Exercises of fatigue design of shafting, gears, and springs. (5L)

Module 4:
Design for Fatigue, Creep and Surface Failure: Surface fatigue design failures. Exercises of surface fatigue design of rolling contact bearings. (5L)

Module 5:
Design for Fatigue, Creep and Surface Failure: Design for creep. Combined creep and fatigue failure prevention. Design for corrosion wear, hydrogen embrittlement, fretting fatigue and other combined modes of mechanical failure. Case Studies of Mechanical Engineering Design Failures. (5L)

Module 6:
Axisymmetric Problems in Design: Thick-Walled Cylinders under Pressure, Compound Cylinders (Press or Shrink Fits). (5L)

Module 7:
Axisymmetric Problems in Design: Rotating Discs and Rotating Cylinders. (5L)

Text Books:

1. Machine Design, Robert L. Norton; Pearson Education India.
2. Optimum Design and Mechanical Elements, Roy C. Johnsons; John Wiley & Sons.
3. Mechanical Analysis and Design, Arthur H.Burr and John B. Cheatham; PHI.
4. Mechanical Design: An Integrated Approach, Ansel C. Ugural & Holmdel

MME2073: COMPUTER AIDED DESIGN OF MECHANICAL SYSTEM

Module 1:
CAD/CAM Systems: Introduction, Need & Scope of Computer Aided Machine Design, 3D Modeling and Viewing. (5L)

Module 2:
Geometric Modeling: Role of Geometric modeling, Curves. (5L)

Module 3:
Geometric Modeling: Surfaces, Solid modeling methods. (5L)

Module 4:
Computer Graphics: 2-D and 3-D transformations, Computer Animation. (5L)

Module 5:
Product Design and Development: Mass Properties, Assembly Modeling, Product Feature recognition from the database, Database structure for CAD, IGES, STEP & DXF data exchange format, Collaborative Design. (5L)

Module 6:
CAD Model & Design: Three-Dimensional modeling applications, Integration of design analysis & CAD. (5L)

Module 7:
Optimization: Overview of optimization methods in design, Formulation of optimization methods in design problems & their solution. (5L)

Text Books:

1. Andrew D. Dimarogonas, Computer Aided Machine Design, Prentice Hall International (USA) Inc.
2. Rao Y.C., Computer Aided Design & Manufacturing
3. Ramboldi and Dillman, Computer Aided Design & Manufacturing, Springer-Verilag.

MME 2075: ENGINEERING DESIGN METHODOLOGY

Module 1:
Fundamentals: principles of design, systematic approach, need analysis and design of specification; Conceptual design: developing function structure, developing concepts by systematic search with physical principles, classifying schemes. (5L)

Module 2:
Concept selection: matrix methods, necessity methods, probability methods, fuzzy set based methods, case study on consumer product; Embodiment design: basic rules, system modeling. (5L)

Module 3:
Preliminary design calculations and material selection, design considerations like force alignment, vibration etc., failure modes and effects analysis, design for manufacturability and assembly, case studies on design of machines. (5L)

Module 4:
Optimal and robust design: design problem formulation for analytical and numerical solution, design of experiments, Taguchi's method. Reverse engineering. (5L)

Module 5:
Physical prototyping; Lab: conceptual design, reverse engineering, design of simple sensors and actuators. (5L)

Module 6:
Hydraulic and pneumatic systems, motors and controller, product teardown and redesign, embodiment design. (5L)

Module 7:
CAE analysis, prototyping, design project. (5L)

Text Book

1. Yousef Haik, Engineering Design Process, Vikas Publishing house, New Delhi,
2. G. Pahl, and W. Beitz, Engineering Design – A Systematic Approach, Springer – Verlag,