

M. Des (MECHANICAL SYSTEMS)

Semester 1

<i>Course No</i>	<i>Course Name</i>	<i>L</i>	<i>T</i>	<i>P</i>	<i>C</i>	<i>Old Cat.</i>
INT 501	Optimization Methods	3	0	0	3	BEC
DES	Product Design & Development	3	0	0	3	DES
DES 502	Product Analysis and Modeling	0	0	3	2	DES
MEC 501	Advanced Mechanisms	3	0	0	3	PEC
MEC 502	Thermal Considerations in Design	3	0	0	3	PEC
MEC 503	Advanced Engineering Simulation Practice-I	1	0	3	3	PEC
DES 503	Product Conceptualization and Visualization	1	0	3	3	DES
Total		14	0	9	20	

Semester 2

<i>Course No</i>	<i>Course Name</i>	<i>L</i>	<i>T</i>	<i>P</i>	<i>C</i>	<i>Old Cat.</i>
	Elective – 1	3	0	0	3	ELE
	Elective – 2	3	0	0	3	ELE
DES 504	Life Cycle Management	3	0	0	3	DES
DES	Design for X	3	0	0	3	DES
MEC	Failure Analysis and Design	3	0	0	3	PEC
MEC 506	Advanced Engineering Simulation Practice-II	0	0	3	2	PEC
DES 506	Product Design Practice and Prototyping	0	0	6	4	DES
Total		15	0	9	21	

Semester 3

<i>Course No</i>	<i>Course Name</i>	<i>L</i>	<i>T</i>	<i>P</i>	<i>C</i>	<i>Old Cat.</i>
	Elective - 3	3	0	0	3	ELE
DES 601	Design for Quality & Reliability	3	0	3	5	PEC
INT 601A	Major Project – Part 1	0	0	9	6	PEC
INT 602	Seminar	0	0	2	1	PEC
Total		4	0	17	15	

Semester 4

<i>Course No</i>	<i>Course Name</i>	<i>L</i>	<i>T</i>	<i>P</i>	<i>C</i>	<i>Old Cat.</i>
INT 601B	Major Project – Part 2	0	0	21	14	PEC
Total		0	0	21	14	

BEC	DES	PEC	ELE	Total
3	18	40	09	70

INT 501	Optimization Methods	3	0	0	3	BEC
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Engineering applications of optimization (3 hours)

Multivariable optimization, method of Lagrange multipliers, Kuhn-Tucker conditions (5 hours)

Convex sets, convex functions, convex programming problems (4 hours)

Linear programming problems and simplex method (6 hours)

Primal and dual problems (2 hours)

Quadratic programming (4 hours)

Introduction to Genetic Algorithms, Traditional optimization methods, Motivation for Genetic Algorithms(2 Hours)

Mathematical Foundations, Operators – Reproduction, Crossover, Mutation, Fundamental Theorem, Schemata Analysis (5 Hours)

GA Implementation Issues, Advanced Operators – Dominance, Diploidy, Abeyance, Extended Schema Analysis (5 Hours)

Applications of Genetic Algorithms, GA based Classifier System, Tabu Search, and Swarm Optimization (4 Hours)

Text Books

1. A Ravindran, D Philips, J Solberg. Operations Research, Principles and Practice, Wiley, 2ndEdn, 2007
2. D E Goldberg. Genetic Algorithms in Search, Optimization & Machine Learning, Addison Wesley, 2009

Reference Books

1. H A Taha. Operations Research, Prentice Hall, 8thEdn, 2009
2. K Deb, Optimization for Engineering Design – Algorithms, Examples, PHI, 2004
3. S SRao, Engineering Optimization Theory & Practice, John Wiley, 2009

DES 501	Product Design & Development	3	0	0	3	DES
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Text Books

Reference Books

DES 502	Product Analysis and Modeling	0	0	3	2	DES
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Analysis through reverse engineering of an existing small product and its components and sub-systems by disassembling a product with attention to product form, its parts and its function in the context of environment of use, materials, dimensions, tolerance, costs and assembly methods.

Suggesting improvement to at least one part / housing/ component of the disassembled product through engineering drawings. Fabrication of a simulation/ mockup model of the improved housing/ component/ part using plastics sheets, wood, metal, board, plaster etc in workshop.

Reference Books

1. Kevin Otto & Kristin Wood; Product Design: Techniques in Reverse Engineering and New Product development; Pearson, Low priced edition 2004.
2. Choudhury S.K Hazra, Elements of Workshop Technology Vol. 1/2, Asia Publishing House, 1986.
3. W A J Chapman, Workshop Technology by, Oxford University Press, 1975

MEC 501	Advanced Mechanisms	3	0	0	3	PEC
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REVIEW OF MECHANISMS AND KINEMATICS (6 Lectures)

Introduction: kinematic links, pairs, chains, and mechanisms; motion: planar vs. spatial; four-bar linkage- relative motion; kinematic diagrams. Six-bar and eight-bar chains; degrees of Freedom; dyads, Grash of criteria, analysis versus synthesis

INTRODUCTION TO KINEMATIC SYNTHESIS (GRAPHICAL AND LINEAR ANALYTICAL METHODS) (20 Lectures)

Task of kinematic synthesis; type synthesis- the associated linkage concept, synthesis of compound-lever snips and yoke riveters; and tools of dimensional synthesis. Graphical synthesis: motion generation-two and three prescribed positions; path generation with and without prescribed timing for three prescribed positions. Review of complex numbers and complex number modeling in linkages Introduction to analytical synthesis: modeling linkages with dyads; dyads, vectors, and complex numbers; standard dyad form input parameters for motion generation, Number of prescribed positions vs. number of free

choices: two, three, four, and five positions; three prescribed positions for motion, path, and function generation, Three-precision-point synthesis; ground-pivot specification.

HIGHER PAIR MECHANISMS (5 Lectures)

Analytical Synthesis

SPATIAL LINKAGES (8 Lectures)

Rigid body and spatial transformations; Spatial mechanisms-displacement, velocity and acceleration analyses; vector synthesis techniques for spatial mechanisms; application to robotics.

DESIGN OF COMPLIANT MECHANISMS (6 Lectures)

Flexibility and deflection, large-deflection analysis, pseudo-rigid body model, force-deflection relationships, compliant mechanism synthesis

Reference Books

1. R.L. Norton , Design of Machinery, Fourth Edition, McGraw Hill, 2007
2. G. N. Sandor and A. G. Erdman, Advanced Mechanism Design: Analysis and Synthesis, Volume 2, Prentice-Hall, New York, 1984.
3. R. S. Hartenberg and J. Denavit, Kinematic Synthesis of Linkages" McGraw-Hill, New York, 1964
4. Larry L Howell Mechanisms, , John Wiley & Sons, Inc, 2001
5. Asok Kumar Mallik, Amitabha Ghosh and Gunter Ditttrich, Kinematic Analysis and Synthesis of Mechanisms, CRC Press, 1994

MEC 502	Thermal Considerations in Design	3	0	0	3	PEC
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Basics of fluid mechanics and heat transfer - Conduction Convection and radiation - Two phase heat transfer - Fins and extended surfaces

Thermal design and analysis: Thermal insulation - structural materials in thermal design – heat exchangers – thermal sensors – automatic temperature control

Effect of temperature in physical properties of material – Thermal stress & strain – Synergetic effect of temperature with mechanical failure modes – Effect of product shape, size & color in heat transfer

Text Books

1. Yunus Cengel; Robert Turner, Fundamentals of Thermal-Fluid Sciences, McGraw-Hill Higher Education, 3rd edition 2008.
2. Ralph Remsburg, Thermal Design of Electronic Equipment, CRC Press, 2000.

Reference Books

1. Eric C. Guyer, Handbook of Applied Thermal Design, CRC Press, 1999.

MEC 503	Advanced Engineering Simulation Practice-I	1	0	3	3	PEC
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Numerical simulation of product behavior under various physical conditions – Simulation of dynamic systems - Kinematic simulation of mechanism - Dynamic analysis of machines. Exercise relevant to implementations of engineering concepts in product design.

Reference Books

1. Chapra. S. C and canale R.P, Numerical Methods for Engineers, Tata McGraw Hill, 2006.
2. Sham Tickoo, Pro/Engineer Wildfire 4.0 for Engineers and Designers, Dreamtech Press, 2009.

DES 503	Product Conceptualization and Visualization	1	0	3	3	DES
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Sketching as a cognitive & creative thinking tool. Expressing, communicating and documenting technical ideas through sketches. Difference between sketching in Art and Design. Introduction to free hand perspective with exercises to sensitize for scale and proportion. Case studies of Leonardo da vanci's engineering sketches.Examples of renderings and coloured representations used by creative designers; story boarding.Aesthetics appreciation using Gestalt principles of examples in products - graphics, Art, painting, sculpture. Overview of 3D CAD as a creative design visualising medium – Visulaisation using Walk thorough, Exploded views, animations. Lab session: Conceptualising a product Form for a everyday use product in the form of perspective sketches. Emphasis on aesthetics, visual quality, finish, texture and colour.Visualising it in 3D CAD rendering software, creating presentation views, walkthroughs, and animations for presentations.

Reference Books

1. Alan Pipes, Drawing for Designers; Laurence King Publishing, London 2007.
2. Jon M.Duff& William A Ross; Engineering Design and Visualisation; CENGAGE Learning, India 2009.
3. Amye. Arntson; Graphic Design Basics; Thomson 2007. (International student edition)
4. John Bowers; Introduction to two dimensional design – understanding Form & Function, John Wiely& Sons. 1999.
5. James. O. Fraioli; Story Boarding – a crash course in professional story boarding,
6. Michale Wise Productions. CA Itten; The Elements of Colour, John Wiely and Sons. 2001.

DES 504	Life Cycle Management	3	0	0	3	DES
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The life cycle management of system – management tasks, life cycle management constraints, life cycle costing.

Product Lifecycle Management: Constructing PLM: PLM Lifecycle Model – Plan, design, build, support, dispose; Threads of PLM: CAD, Engg. Data Management, Product Data

Management, Computer Integrated Manufacturing; Characteristics of PLM: Singularity, Correspondence, Cohesion, Traceability, Reflectiveness, Cued Availability.

Product End Life: Design for end of old product management - Problems of old products in emerging markets - Recovery and economic feasibility of materials such as plastics, rubber aluminum, steel, etc.

Tradeoffs: Applying life cycle thinking to define tradeoffs along the supply, manufacture-use and end of life chain-Effect on the customer-Expectation of the customer-Evaluate product cost versus operating cost, durability, environment and health.

Maintainability- Objectives of maintenance, types of maintenance, factors affecting maintainability, system down time, and maintainability trade-off.

Sustainability: What is sustainability-Use of renewable resources-View to design horizon.

Text Books

1. AnttiSaaksvuori; AnselmiImmonen, Product Lifecycle Management, Springer, 3rd Edition, 2010.
2. Stephen M. Samuel; Eric D., Weeks and Mark A. Kelley, Team-center Engineering and Product Lifecycle Management Basics, Design Visionaries, Inc., 1st Edition, 2006.

Reference Books

1. John Stark, Product Lifecycle Management: 21st century Paradigm for Product Realization, Springer, 1st Edition, 2004.
2. Product Lifecycle Management: Driving the Next Generation of Lean Thinking, Michael Grieves, McGraw-Hill, 2005.

DES	Design for X	3	0	0	3	DES
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Reference Books

MEC	Failure Analysis and Design	3	0	0	3	PEC
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Text Books

Reference Books

MEC 506	Advanced Engineering Simulation Practice-II	0	0	3	2	PEC
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Simulation and analysis of mechanical system using sophisticated tools – Finite Element Analysis concepts – Analysis of products - Implementation of FEA results in Product design.

Reference Books

1. Karris S. T, Introduction to Simulink with Engineering Application, Orchard Publications, 2006.
 2. Logan. D. L, A First Course in the Finite Element Method, Thomson, 2007.
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DES 506	Product Design Practice and Prototyping	0	0	6	4	DES
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Interdisciplinary team based product design practice oriented project.

Teams will chose a real world or industry sponsored problem / product/ situation to work upon. Students will plan the project, Conduct user requirement study, market opportunities and competitive product study, develop product specification, conduct IPR audits, Conceptualize, visualize & build a prototype/ mockup. Regular presentations of progress and evaluation by other teams.

Reference Books

1. Clive Dym& Patrick Little; Engineering Design: a project based introduction, Johan Wiley & Sons.2004.
2. James Garratt; Design and Technology; Cambridge University Press 1998.
3. Richard Birmingham et al; Understanding Engineering Design, PHI Delhi 1998.

DES 601	Design for Quality & Reliability	3	0	3	5	PEC
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VOC- CTQ & its characteristics- Data collection techniques- QFD- System Modeling Techniques - Measurement & Error - Gauge performance- Gauge calibration- R&R study- Benchmarking- Concept Generation Process- Concept Development Techniques - TRIZ- Design Tradeoff Analysis- Design for Reliability - Reliability Analysis- Reliability Testing- Probability Distributions- Performance Standards - Process Capability- Risk Assessment- Design of Experiments- Response Surface Models- Process Capability Modeling- Computation of variation- Probabilistic Optimization- Robust Design- Tolerance Analysis- Design verification - Reliability Testing - Control charts.

Central Limit Theorem for a family of reliability measures, modeling and reliability analysis of multi-state systems, Weibull data analysis for few or no failures, Markovian performance evaluation methods, software reliability and testing,

In this course students will design a component using above mentioned techniques.

Text Books

1. Betsterfield D.H. Quality Control, Prentice Hall Publication, 8th Edition, 2008.
2. K.C. Kapur, L.R. Lamberson, Reliability in Engineering Design, John Wiley & Sons, 1st Edition, 1977.

Reference Books

1. A.Birolini, Reliability Engineering, Theory and Practice, Springer, 5th Edition, 2005.
2. Recent Advances in Reliability and Quality in Design, Hoang Pham, Springer Series in Reliability Engineering, ISBN: 978-1-84800-112-1, 2008.
3. Introduction to Statistical Quality Control, Douglas, C. Montgomery, John Wiley & Sons, NY, 2009.

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