Course Handout: MEI 502B MODELING AND SIMULATION OF MANUFACTURING SYSTEM				
M.Tech. Semester II (Mechanical Engineering)				
L	**T**	**P**	**Credits**	**Class Work : 25 Marks**
4	**-**	**--**	**4**	**Examination : 75 Marks**
Scheme for Sessional Awards: As per PG acad. Ordinance				**Total : 100 Marks**
Duration of course: As per Univ. acad. Calendar				**Duration of Examination : 3 Hours**

Course objectives: In the contemporary competitive environment, manufacturing industries must structure their resources and processes in such a way that insure them strategic as well as operational advantages. This course aims to equip students the knowledgebase for study on system models before it is actually implemented. The course is aimed to facilitate modelling of manufacturing systems for the study of different strategic as well operational initiatives in different functional areas, like inventory management, shop floor control, capacity planning, layout design and supply chain planning. It is structured with a view to conceptualize statistically valid modelling framework which helps to optimize experimental setup for study of system. The course aims to strengthen the professional excellence of students for a rewarding career in manufacturing simulation domain, academics and research.

Course Outcomes: After completing the course, the graduates acquire knowledge to study industrial systems and ensure optimum system performance before the actual system is put in place. It enables them capability to study industrial systems through simulation models of machines, production systems, FMS, inventory systems, logistic systems and supply chains. Such modelling studies helps in planning decisions. It also provides methods for selection of alternative resource and process plans for industrial and supply chain resources. After undergoing the course, the students are able to perform experimental design, data acquisition and presentation, data reduction and interpretation using software tools. The course prepares graduates towards rewarding career as well as research in simulation of industrial systems.

The course structure and teaching plan are given below.

UNIT I	INTRODUCTION: Concept of System and environment, Continuous and discrete systems, Linear and non-linear systems, Stochastic processes, Static and Dynamic models, Principles of modeling, Basic Simulation modeling, Role of simulation in model evaluation and studies, Steps in a simulation study, Verification, validation and credibility of simulation models, Advantages, disadvantages and pitfalls of simulation,	6 lectures
	STATISTICS IN SIMULATION: Review of basic probability and statistics, random variables and their properties, Statistical analysis for terminating simulation and steady state parameters	5 lectures
UNIT II	MODELLING ELEMENTS IN MANUFACTURING SYSTEMS: Definition, Classifications and characteristics of production systems; measures of manufacturing systems performance, modelling elements in manufacturing systems: processes, resources, single and multi server queues, arrival processes, service times, downtime, manufacturing costs, resources selection rules, different manufacturing flexibilities	6 lectures
	SIMULATION OF MANUFACTURING SYSTEMS: Simulation of Job shop, batch and Flexible manufacturing systems, Case studies for above systems.	5 lectures

UNIT III	MODELLING OF MANUFACTURING SUPPLY CHAINS (SC): Introduction of SC, Modelling elements in SC, Measures of SC performance, brief review of bear game, SC initiatives and effect on SC performance Modelling of Supply Chain Processes at different Supply chain nodes like: Retailer, assembler, distributor, and manufacturer;	6 lectures
	Modelling of different SC processes: inventory control policies like (s, S), (s, Q) systems, production control issues like Manufacturing-to-order, Manufacturing-to-stock, Assembleto-order, Assemble-to-stock; Modelling of material transport system in SC, Development of Simple SC models	5 lectures
UNIT IV	DESIGN OF SIMULATION EXPERIMENTS: Consideration for selecting length of simulation run, no of replication and warm-up period, elimination of initial bias, Finance Considerations of a simulation study, Variance reduction techniques, 2 k factorial design, fractional factorial design, factor screening, response surface, Meta-models and sensitivity, optimization procedures	6 lectures
	SIMULATION LANGUAGES: Discussion of Continuous and discrete simulation languages, Salient features of important simulation packages like SIMSCRIPT, GPSS SIMULA, ARENA, PROMODEL etc., importance and limitations of special purpose languages.	5 lectures

TEXT BOOKS:

1. Simulation Modeling and Analysis, 3e, Law A.M. and Kelton W.D., TMH, New Delhi
2. 2. Simulation with Arena - Kelton and Sadowski, 2003, (McGraw-Hill)
3. Analysis and Control of Production Systems, Printice Hall Publn, E.A. Elsayed and T.O. Boucher, 1994.
4. Modelling and Analysis of Dynamic Systems, C.M. Close and Dean K.F., Houghton Mifflin
5. Simulation of Manufacturing, Allan Carrie, John Wiley & Sons
6. System Simulation, Geoffrey Gordon, Prentice Hall, 1998
7. Modern Production /Operations Management, 8e, Buffa E.S. and Sarin R.K., John Wiley
8. Designing and Managing the Supply Chain, 3/e, Simchi-Levi D., Kaminsky P., Simchi-Levi E., Shankar R., TMH, New Delhi

Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit (1 & 2 from unit I, 3 & 4 from unit II, 5 &6 from unit III and 7 & 8 from unit IV). The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.

Course Coordinator: Dr. M N Mishra	**Consultation Hours: Thursday, 2-4 PM**

MET 502B DESIGN OF THERMAL & ENERGY SYSTEMS

M. Tech. Semester – II (Mechanical Engineering)

L	T	P	Credits	Sessional Marks : 25
4	--	--	4	Theory Marks : 75
				Duration of Exam : 3 Hours

OBJECTIVES:

1. With the growth of thermal and energy systems related to the energy conversion, pollution, automobiles, and refrigeration and air conditioning; there has been a need to develop such advanced course for thermal system design since long.
2. This course, therefore, is designed for post graduate students to fulfil the requirement of growing worldwide challenges in this arena.
3. The course offers a systematic approach for various considerations that lead to a workable and, finally, to an optimal design; uses up-to-date examples and problems from diverse fields (i.e., energy systems, cooling of electronic equipment, refrigeration, environmental problems, engines, heat transfer equipment, and manufacturing), and presents the most current information and design tools available worldwide.
4. While describing fundamentals, few strategies including knowledge-based design have been included to facilitate the coupling of different systems and handling of large thermal systems.
5. The contents of course, application of computational tools and the effective pedagogy are aimed to inculcate deeper research potency and confidence.

OUTCOMES:

1. The course outcome can be expected towards enhancing modeling, simulation and optimization skills, ability to selecting adequate modeling level, right tool for simulation and optimization for specific application, and expertise in data reduction and fitting the data followed by good exposure to latest software.
2. The capacity to conceive the sound knowledge based on latest trends, deep discussions in class room environment and expertise of latest computational software skills should be reflected in learner in terms of confident and successful engineers, innovators, scientists and entrepreneurs who may contribute to country growth and global community as well.

BOOKS

1. Design of Thermal Systems – W.F. Stockers, MH, New York.
2. Design & Optimization of Thermal Systems – Yogesh Jaluria, MH, New York.
3. Analysis & Design of Energy Systems – Hodge BK, Prentice Hall, 1990, New Jersey.
4. Optimization Methods for Engineering Design – Fox RL, Addison-Wersley, Reading, MA.
5. Dhar Conceptual Design for Engineers - Michael French, 3rd Ed., Springer
6. Thermal design and Optimization – Bejan A., Tsatsaronis G., and Moran M., Wiley, New York
7. Elements of Thermal-Fluid System Design – Burmeister LC, Prentice Hall, 1998.
8. Principles of Design – N.P. Suh, Oxford Univ. New York.
9. Applied Numerical Methods – Carahan, B.H. Luther, H.A. and wilkes, J.O. Wiley, New York.
10. Numerical Methods – Hornbeck, R.W., PH, Anglewood, New York.

LECTUREWISE PROGRAMME: (from 08.01.18 to 27.04.18)

	L
UNIT-I	
INTRODUCTION (from 08.01.18 to 12.01.18)	
Introduction to Thermal and Energy systems	1
basics of heat exchangers, condensers, evaporators	1
basics of compressors, steam generators, gas turbines, gasifiers, combustors, IC engines,	2
basics of water heaters, pumps and fans, cooling ponds, re-circulating flow in enclosed spaces, fire induced flow in partial enclosures	1
CONCEPT OF ENGINEERING DESIGN: (from 15.01.18 to 27.04.18)	
Basic concepts of engineering design	1
Engineering design types: thermodynamic design, thermal design and mechanical design;	1
Engineering design process: Initial design	1
Conceptual design and Acceptable design	1
Optimal design; Material selection and its properties.	1
UNIT-II	
STATISTICAL MODELING: (from 08.01.18 to 25.01.18)	
Dimensional analysis;	1
Curve interpolation; Best fit: Method of least squares;	1
The art of curve fitting; Goodness of fit; Physical model;	1
Relations among performance characteristics: Performance characteristics of system-components using curve fit;	1
An overview of statistical modeling.	1
Mathematical modeling: Basic principles of modelling	1
Governing equations, Boundary conditions, Solution procedure of simultaneous algebraic/differential equations	1
linear/non-linear equations; Numerical modeling	1

MATHEMATICAL MODELING: (from 29.01.18 to 05.02.18)

Applications to thermal/energy systems - Heat Exchangers, Condensers,	2
Evaporators, Compressors, Steam generators, Gas turbines, Biomass gasifier, Combustors, IC Engines, Water heater and prime movers.	5

SIMULATION OF THERMAL AND ENERGY SYSTEM: (from 06.02.18 to 21.02.18)

Introduction to system simulation, Information flow diagrams; Classes of simulation	3
Principles and methods of system simulation	1
Successive substitution, Newton's method	2
Hardy-Cross approaches	2
Overview of system simulation	1

UNIT-III

ECONOMIC CONSIDERATION: (from 22.02.18 to 07.03.18)

Calculation of interest; Time value of money;	1
Raising capital; Taxes;	2
Economic factors in design	2
Application to engineering systems	2
Numerical problems	2

OPTIMIZATION METHODS (from 08.03.18 to 27.03.18)

Introduction to optimization techniques: Lagrange multiplier methods,	2
Search methods	3
geometric and dynamic programming	3
Genetic Algorithms	2
Simulated annealing	2
Monte-Carlo method	1

UNIT-IV

KNOWLEDGE-BASED DESIGN: (from 28.03.18 to 12.04.18)

Introduction to knowledge-based design:	1
Expert knowledge, material data base	1
design methodologies	1
Computer-aided knowledge based optimum design to thermal and energy systems	2
Applications to thermal/energy systems:	3

APPLICATIONS TO THERMAL/ENERGY SYSTEMS (from 13.04.18 to 27.04.18)

Optimum speed of a tanker	2
Solar collector and storage tank	2
Optimum thickness of insulation	1
Optimization of water chilling plant	1
Liquefied natural gas facility; Natural-convection air cooled condenser,	2
Heat pump for pasteurizing milk	1
Optimization with more than one degree of freedom: Heat Exchanger.	2

Home Assignments :4 –5 assignments are given during the semester.

Evaluation Procedure

1.	Surprise Quiz/ Tutorial Test	5 Marks
2.	Assignment / Project / Performance in the Class	5 Marks
3.	Minor Tests (Two tests having equal weightage) Minor Test I : 14-16 Feb, 2018 Minor Test II : 4 -6 April, 2018	15 Marks
4.	Major test (University Examination)	75 Marks

Award of Grades Based on Absolute Marks: The University is following the system of grading based on absolute marks (after applying moderation if any). Following grading will be done based on the % of marks obtained in all the components of evaluation part of the subject.
A+ (90% - 100 %), A (80% - 89%), B+ (70% - 79%) , B(62% - 69%), C+ (55% - 61%), C (46% - 54%), D (40% - 45), F (Less than 40 %)

For F grade, a candidate shall be required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject
Chamber consultation hour: Any vacant period.

Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit (1 & 2 from unit I, 3 & 4 from unit II, 5 &6 from unit III and 7 & 8 from unit IV). The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.
3. The use of properties (water, air, steam etc) tables, heat transfer tables, charts is permitted

(Dr. Avdhesh Kr. Sharma)

MED 506B VIBRATION AND CONDITION MONITORING

L T P Credits
4 0 0 4

Class Work: 25 Marks
Examination : 75 Marks
Total: 100 Marks
Duration of Examination: 3 Hours

Scope and objective of the course: The objective of this course remains to apprise students about the practical importance of vibration at the level of appreciation and to make students comprehend the condition of the health of the rotating machines based on vibration. It also helps students to model the machine for vibration analysis.

Students will be able to learn about:

1. The students will appreciate vibration from the view point of motion and energy.
2. the students learn to model real machine in to suitable vibratory system in terms of mass, spring and damping plus degree of freedom.
3. To determine the vibratory response of a vibratory systems employing different methods such as Newtonian approach and energy approach.
4. The students will learn how to apply the analytical knowledge of vibration in desiging , different kind of vibration measuring equipments such as vibrations pickups, vibration shaker etc. and how to integrate them to measure vibration signals.
5. The students learns about the condition monitoring of the machines based on vibration signals using different techniques such as Rap Test, sweep test, Time Domain Analysis and frequency domain analysis.

The course structure and teaching plan along with schedule are given below

UNIT-I	**BASIC CONCEPTS AND ONE DEGREE FREEDOM SYSTEM:** Concept of free and forced vibration using spring mass model, **(08.01.2018)** governing equation and response to an initial disturbance for an undamped spring mass system; **(09.01.2018)- (10.01.2018)** Concept of linear and non-linear vibratory system. **(15.01.2018)- (10.01.2018)** Natural frequency and its determination using the concept of equivalent system and energy methods - Average energy principle, **(10.01.2018)- (16.01.2018) (17.01.2018)- (18.01.2018)-** principle of conservation of energy; principle of virtual work - Hamilton s principle and Lagrange s equation **(23.01.2018) (24.02.2018)- (25.01.2018),**	12

UNIT-II	**DAMPED SINGLE DEGREE FREEDOM SYSTEM- FREE AND FORCED VIBRATIONS**: Damping models with stress on viscous damping; Governing equation and response for over damped, critically damped and under damped systems; **- (29.01.2018), (30.01.2018)- (01.02.2018)** Logarithmic decrement and its practical significance; **(05.02.2018)- (06.02.2018)** negative damping self exited vibration. Governing equation under harmonic excitation and response using technique of calculus and phasor diagram; **(07.02.2018)- (08.02.2018) (12.02.2018)** Active and passive vibration isolation, transmissibility; bending critical speeds of simple staffs; Support motion; seismometer, accelerometer; **(13.02.2018) (19.02.2018) (20.02.2018) (21.02.2018)** ,	12
UNIT-III	**MULTI DEGREE FREEDOM SYSTEM AND NUMERICAL TECHNIQUES**: Concept of mode shape through 2- DOF system governing equations and response under general initial conditions; **- (22.02.2018), (01.03.2018) -(05.03.2018)** Vibration absorber; Eigen value problems close coupled system and far coupled system; orthogonality of mode shapes.**(06.03.2018),(07.03.2018) (08.03.2018), (12.03.2018)** Dunkerieys lower bound approximation, **(13.03.2018),(14.03.2018) (15.03.2018)** Rayleigh s upper bound approximation; Myklestad- Prohl method for far coupled system; **(19.03.2018) (20.03.2018)** Finite element method for far coupled system as well as closed coupled system., **(21.03.2018) (22.03.2018) (26.03.2018)**	15
UNIT-IV	VIBRATION MEASUREMENT AND CONDITION MONITORING Basic vibration measuring set up amplitude and phase measurement; **(27.03.2018)** vibration pick- ups general construction and working principle of piezoelectric accelerometer and eddy current based displacement probe;**, (28.03.2018)- (02.04.2018)- (03.04.2018)** filters- unfiltered and filtered signals; Display devices- vibration analyzer and oscilloscope; General construction and working principle of electro-dynamic vibration shaker. Fourier series &Fourier Transforms, Fast Fourier Transform (FFT), **(04.04.2018) (05.04.2018) (09.04.2018)** concept of time domain and frequency domain. Condition Monitoring Philosophy its need and types; concept of 1X, 2X, 3X, ---vibration signals in a rotating machines; Time domain analysis- time waveform, orbit analysis, phase analysis; **(10.04.2018)** Frequency domain analysis: frequency spectrum, bode plot, **(16.04.2018) (17.04.2018)** cascade plot; Recent techniques of condition monitoring. **(19.04.2018) (23.04.2018) (24.04.2018)**	13

Reference Books:

1 Theory and Practice of Mechanical Vibrations by Rao J S and Gupta K; New Age Publication.

2 Theory of Vibration with applications by William T Thomson

3 Mechanical Vibrations by S S Rao (2008)

4 Fundamental of Vibration by L Meirowitch (2008)

Home Assignments: 4 –5 assignments are given during the semester.

Evaluation Procedure

1.	Surprise Quiz/ Tutorial Test	5 Marks
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For F grade, a candidate shall be required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject

Chamber consultation hour: available at per convenience of students

(Dr. K.D.Gupta)

MET 504B ADVANCED HEAT TRANSFER

L	T	P	Credits		
4	-	-	04	Sessional Marks: 25	
				Theory Marks:	75
				Duration of Exams:	3 Hours

OBJECTIVES:

1. To review the basic concept of Heat Transfer.
2. To develop an intuitive understanding ofthermal contact resistance and circumstances under which it may be significant.
3. To identify applications in which insulation may actually increase heat transfer
4. To analyze finned surfaces and assess how efficiently and effectively fins enhance heat transfer
5. To solve multidimensional practical heat conduction problems
6. To visualize the development of velocity and thermal boundary layers during flow over surfaces for laminar & turbulent flow
7. To develop an intuitive understanding of friction drag and evaluate the average drag and convection coefficient in external flow
8. To evaluate heat transfer over external surfaces like flat plate, cylinder, sphere, bundle of tubes.
9. To analyze heating and cooling of a fluid flowing in a tube under constant surface temperature and constant surface heat flux conditions
10. To study the rate of heat transfer during such liquid to vapour and vapour to liquid phase transformation
11. To analyze heat exchangers for various conditions of temperatures & flow configuration.
12. To study the importance of view factor in radiation heat transfer
13. To quantify the effect of radiation shield on the reduction of radiation heat transfer between two surfaces.

OUTCOME:

1. Able to know the variation of temperature distribution & design the equipment of heat exchangers, boilers, chemical reactors, flow modeling, power industry, chemical processes, aerospace, food processing, petrochemical, metallurgical, refrigeration, cryogenic industry, brewing, dairy industry.
2. Able to know the temperature distribution in solids.
3. Able to find heat transfer for flow over bodies such as flat plat, cylinders, spheres or aerofoil, bundle of tubes in heat exchangers, turbine blades, hot metal surfaces, internal fluid flow, film condensation, boiling, hot atmosphere to any surface etc.
4. Able to find temperature distribution through numerical techniques.
5. Able to imbue the motivation in students for continuous learning and improvement of technical advancement & skills.

Books :

1. Fundamentals of Heat and Mass Transfer – Sarit K. Dass, Narosa Publishing House, New Delhi.
2. Fundamentals of Heat and Mass Transfer – Frank P. Incropera, Published by John Wiley & Sons, New York.
3. Heat & Mass Transfer – P.K. Nag, Published by Tata-McGrawhill, New Delhi.
4. Heat Transfer – J.P. Holman, Tata McGraw Hill, New Delhi.
5. Fundamentals of Engineering Heat and Mass Transfer – R C Sachdev, Published by New Age International (P) Limited, New Delhi.

LECTUREWISE PROGRAMME : (from 08.01.18 to 27.04.18)

Introduction of the subject (08.01.18)	1
UNIT- I	
STEADY STATE HEAT CONDUCTION (09.01.18 to 20.01.18)	
Reviews of basic laws of Conduction, Convection and Radiation	1
Thermal insulation problem, thermal contact resistance	1
Fins with uniform cross-sectional area,	1

Fins variable cross-sectional area- circumferential, triangular and parabolic shape, Fin effectiveness and efficiency	3
MULTI-DIMENSIONAL HEAT CONDUCTION (23.01.18 to 31.01.18)	
Methods for the solution of the Multi-Dimensional heat conduction problem: Analytical Method, Graphical Method, Electrical Analogy, Numerical Methods	3
Numericals	2
UNIT- II	
EXTERNAL FLOW AND FORCED CONVECTION (02.02.18 to 23.02.18)	
Introduction, Exact and approximate integral solutions for the flow over flat plate, hydrodynamic & thermal boundary layer, boundary layer thickness, drag coefficient , mean drag coefficient, The local & average heat transfer coefficient, mass flow through the boundary	3+3
Turbulent flow over flat plate, Reynolds analogy, Reynolds-Colburn analogy	1
Drag & heat transfer in mixed boundary layer,	1
Flow over curved surfaces, Cylinder, Sphere, Cross flow over banks of tubes	1
Numericals	2
UNIT – III	
INTERNAL FLOW AND FORCED CONVECTION (26.02.18 to 14.03.18)	
Introduction, Entrance region, Fully developed region, Mean velocity, Governing differential equation and velocity profile for fully developed laminar tube flow, Hagen-Poiseuille equation, Fanning friction coefficient,	2
Mean temperature, Heat transfer for fully developed laminar tube flow: Governing differential equation, heat transfer coefficient for constant wall temperature and constant wall heat flux boundary conditions	2
Velocity distribution in turbulent flow through pipe, Fluid friction, Convection Correlations for turbulent flow in tubes: Reynolds Analogy, Reynolds-Colburn analogy, Dittus- Boelter equation, Sieder and Tate equation, Petukhov expression	2
Numericals	2
TWO PHASEHEAT TRANSFER (16.03.18 to 26.03.18)	
Heat Transfer with Change of Phase: Laminar film condensation on a vertical plate, Drop-wise condensation, Boiling regimes, Nucleate and film boiling, Heat pipe	2
Numericals	2
UNIT – IV	
HEAT EXCHANGERS (27.03.18 to 17.04.18)	
Classification and selection of heat exchangers, Some important definitions	1
Heat Exchanger Analysis: Use of LMTD, Multipass heat exchangers	1
Effectiveness – NTU Method	1
Plate heat exchanger, evaporative tubular heat exchanger	1
Evaporative Effectiveness, Dryout heat flux, Design of Shell and Tube Heat Exchanger	1
Simulation of heat exchangers, Pressure drop and Pumping power, Optimisation of heat exchanger size	1
Numericals	2
THERMAL RADIATION (18.04.18 to 27.04.18)	
Review of basic laws for radiation-, Black body concept, gray body radiation, Solar radiations	1
Radiation between surfaces- Shape factor and correlations	1
Radiation exchange between surfaces in black enclosure, Network representation, Radiation exchange in gray enclosure,	1
Apparent emissivity of a cavity, Radiation shields, Radiations in emitting and absorbing media	1

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(Dr. Raj Kumar)

MEP-504B ANALYSIS OF MANUFACTURING PROCESS

M.Tech. Semester-II (Mechanical Engineering)

Course Objectives and Outcomes

Course Objectives

- The course highlights the advances in cutting tool material, design principles and selection of cutting tool materials.
- The objective of the course is to provide the students with the fundamental concepts, the necessary knowledge and the basic skills related to manufacturing process and their analysis.
- The objective of this course is to familiarise and prepare the students to analyze various manufacturing process such as metal cutting, casting, welding and plastic deformation process.
- Course imparts not only the working principles and design aspects but emphasizes the economical aspects of various manufacturing processes.
- To course imparts the problems, scope and survey of various manufacturing industries.
- The course intends to expose the students to the concept of economic of machining and to help them to learn the techniques of estimating the cost of various machining processes and related characteristics.

Course Outcomes

- The students are able to understand the minimum cost, maximum rate of production and economical aspects of manufacturing process.
- The students are able to model and analyze the various manufacturing process.
- The students are able to understand the design aspect of forming, casting and welding process.
- The students are able to understand the quality and testing of manufacturing process.
- Students are able to understand the design principles of cutting tools and various manufacturing process.
- Understand and apply particular method of manufacturing for a production system.

Lecture Plan

	COURSE CONTENTS	Lect. Hrs	Total Hrs
UNIT - I	**MACHINABILITY AND ECONOMICS OF MACHINING**		**12**
	Characteristics of tool material, advances in cutting tool material, role of coating.	2	
	Observation in metal cutting, Energy considerations in machining, Modern theories in mechanics of cutting, Review of Merchant and Lee Shaffer theories, critical comparison	3	
	Measurement of cutting forces-Classification of cutting force dynamometers, Machinability, evaluation of Machinability, mechanism of tool failure, tool wear mechanism, tool life and tool life equation	3	
	Need for rational approach to the problem of cutting metals, factors affecting Machinability surface finish and surface integrity	2	
	Economics of machining cost of turning operation, optimum cutting speed for minimum cost and maximum rate of production	2	
UNIT- II	**BULK DEFORMATION PROCESS**		**12**
	Stress-Strain relations in Elastic and plastic deformations	1	
	Yield criteria for ductile metals, work hardening and anisotropy in yielding Flow curves. Slip Line Field Theory	3	
	Effects of temperature and strain rate in metal working, friction and Lubrication in Hot and Cold working.	3	
	Technology and analysis of important metal forming processes – Forging, Rolling, Extrusion, Wire drawing, Sheet metal forming processes	5	
UNIT-III	**CASTING, GATING AND RISERING SYSTEMS**		**15**
	Introduction, Features of Casting problems, Survey and Scope of Foundry Industry	2	
	Solidification of pure metals, Nucleation and growth in alloys, Solidification of actual casting	2	
	Progressive and directional solidification	1	
	Centreline feeding resistance, Rate of solidification, Chvorinov s rule	1	
	Gating systems and their characteristics, Effects of gates on aspiration	2	
	Turbulence and dross trap, recent trends, Riser design, Risering curves	2	
	NRL method of riser design	1	
	Feeding distance, Risering of complex casting, Risering of alloys other than steel	2	
	Riser design by geometrical programming	2	
UNIT-IV	**WELDING METALLURGY**		**13**
	Welding as compared with other fabrication processes, Classification of welding processes	2	

	Heat affected zone and its characteristics; Effects of alloying elements on weldability	3	
	Weldability of steels, cast iron and aluminium and alloys, Weld testing standards, heat transfer and solidification, Analysis of stresses in welded structures	1	
	Pre and post welding heat treatments, Metallurgical aspects of joining	2	
	Conditions of soldering, Brazing and welding of materials	2	
	Weld Design & Quality Control: Principles of sound weld design, Welding joint design, Welding defects;Testing of weldament.	3	

TEXT BOOKS

1. Metal Cutting Principles M.C. Shaw Oxford Clarendon Press
2. Metal Cutting Theory and Practice Bhattacharya New Central Book Agency
3. Fundamentals of Metal Cutting and Machine Tools B.L. Juneja and G.S. Sekhon New Age International
4. Principles of Manufacturing Materials & Processes Campbell J. S., Publisher Mc Graw Hill.
5. Principle of Metal casting - Rosenthal, Tata McGraw Hill, New Delhi
6. Meta Casting: Principles and Practice TV Rammana Rao New Age International
7. Welding and Welding Technology, Richard L. Little Tata McGraw Hill Ltd.
8. Manufacturing Processes and Systems: Ostwald Phillip F., Munoz Jairo, John Wiley & Sons
9. Plasticity for Mechanical Engineers Johnson & Mellore Van Nostrand

Pardeep Kumar
Assistant Professor
Department of Mechanical Engineering.
DCRUST, Murthal

MET 601B REFRIGERATION & AIR CONDITIONING SYSTEM DESIGN

M. Tech. Semester – II (Mechanical Engineering)

L	P	Credits			
4	--	4	Class Work	:	25 Marks
			Examination	:	75 Marks
			Total	:	100 Marks
			Duration of Examination	:	3 Hours

COURSE OBJECTIVES:

The objective of this course is to prepare the students to carry out the analysis and design of refrigeration and air-conditioning systems. Course imparts knowledge not only on working principles and design aspects but emphasizes the environmental aspects of refrigerants used in Refrigeration and Air Conditioning (RAC) industry. The students will be benefited by learning the design aspect of various components of vapor compression(VC) and Vapor absorption refrigeration system (VAR).

It covers the principles of psychrometry and applied psychometrics. The students will gain knowledge about air conditioning cooling and heating Load calculations, comfort scales and duct design etc.

Other types of relevant cooling technologies like vortex, thermoelectric and desiccant systems etc are included to update student on the latest alternate research going in RAC industry other than from conventional means like multi-stage vapor compression and cascade systems which is also taken care in the curriculum.

COURSE OUTCOME:

Student will be able to understand:

- Environmental impact of RAC
- Analysis of Multi staging, multi evaporator and cascade system
- Component Design and analysis VARS and VCRS
- Applied psychometrics; Building Load Calculation; Duct design
- Alternate cooling and refrigeration technologies like Thermoelectric etc

Text books:

1. Refrigeration and Air-conditioning –CP Arora, Tata-Mc Graw Hill.
2. Refrigeration and Air-conditioning – W.F. Stockers, Tata-Mc Graw Hill.
3. Design of Thermal Systems – W.F. Stockers, MH, New York.

Reference books:

1. ASHRE Handbook, American Society of heating, refrigerating and Air-Conditioning Engineers (ASHRE) .

Lecture Plan:

Introduction **1 Lecture**

UNIT – I **8 Lectures**

REFRIGERATION AND AIR CONDITIONING LOAD CALCULATIONS: Solar heat gains through structures, ASHRE simplified calculation procedure.
REFRIGERATION: Environmental impact of HVAC system and Refrigerants. Properties and relation of pure mixed refrigerants, Analysis of VCR cycle-multistage, multi-evaporator and cascade systems.

UNIT – II **10 Lectures**

THERMAL DESIGN: Compressors, different evaporators –DX type etc, Condenser – water and air cooled, Capillary, Absorber and Generator of vapour absorption system, Analysis of vapour absorption cycles – Aqua ammonia and LiBr-water cycles.

UNIT – III **14 Lectures**

AIR CONDITIONING: Psychometric process, air conditioning calculation, comfort scale, design conditions, solar heat gains. Cooling and heating load calculations. Design of air conditioning equipments-cooling and dehumidifying coils. Air distribution systems - duct design, air handling units, Energy recovery and thermal storage, Indore air quality, various dehumidification technologies, commercial software used for air conditioning load calculations.

UNIT – IV **8 Lectures**

REFRIGERATORS AND CONDITIONING TECHNOLOGIES: Vertex tube, thermoelectric, acoustics, desiccant cooling, solid and liquid systems, steam jet refrigeration.

Evaluation Procedure:

Sessional Test : 60%; Assignment : 20%; Surprise Quiz : 20%

1.	Surprise Quiz/ Tutorial Test	5 Marks
2.	Assignment / Project / Performance in the Class	5 Marks
3.	Minor Tests (Two tests having equal weight age) Minor Test I : 14-16 Feb, 2018 Minor Test II : 4 -6 April, 2018	15 Marks
4.	Major test (University Examination)	75 Marks

Home Assignments :4 –5 assignments are given during the semester.

Award of Grades Based on Absolute Marks: The University is following the system of grading based on absolute marks (after applying moderation if any). Following grading will be done based on the % of marks obtained in all the components of evaluation part of the subject. A+ (90% - 100 %), A (80% - 89%), B+ (70% - 79%) , B(62% - 69%), C+ (55% - 61%), C (46% - 54%), D (40% - 45), F (Less than 40 %) For F grade, a candidate shallbe required to appear in the major test of concerned course only in the subsequent examination(s) to obtain the requisite marks/grade.

Attendance Record – Candidate should attend at least75% attendance of the total classes held of the subject

Chamber consultation hour: Any vacant period.

Note:

1. In the semester examination, the examiner will set 08 questions in all selecting two from each unit (1 & 2 from unit I, 3 & 4 from unit II, 5 &6 from unit III and 7 & 8 from unit IV). The students will be required to attempt only 5 questions selecting at least one question from each unit. All questions will carry equal marks.
2. The use of scientific calculator will be allowed in the examination. However, programmable calculator and cellular phone will not be allowed.
3. The use of refrigerant properties , air, steam etc tables are permitted.

Course Coordinator

Dr Amit Sharma

Assistant professor, Mech. Engg Deptt., DCRUST Murthal

MED 502B SYSTEM DYNAMICS AND CONTROL

L	T	P	Credits	
4	-	-	04	Sessional Marks: 25 Theory Marks:75 Duration of Exams: 3 Hours

OBJECTIVES:

1. To understand different types of models of a physical system, and dynamics of physical system.
2. To develop mathematical model as system state differential equations of a physical system.
3. To understand manifestation of energy, and power flow among subsystems of a system in all engineering and science domain.
4. To learn bondgraph modeling approach, which is based upon power flow among various subsystems of a system.
5. To model dynamics of physical system from different energy domains.
6. To simulate transient and steady state response of first and second order systems for different inputs both analytically and using bond graph approach.
7. To understand multi or vector bonds to model field of continuum of a physical system

OUTCOME:

1. Able to understand various gradients which causes dynamics is physical systems
2. Able to model dynamics of physical systems from mechanical, electrical, hydraulic, chemical, electronics and other engineering domain.
3. Able to develop state differential equations for dynamics of different physical system.
4. Able to develop MATLAB code to solve and simulate dynamics of system from all energy domain
5. Able to simulate transient and steady state response to various input to first and second order system.

Books :

1. SYSTEM DYNAMICS: Modeling and Simulation of Mechatronics Systems by Dean C. Karnoop, Donald L. Margolis, Ronald C. Rosenberg. John Wiley & Sons, INC

2. Bond Graph in Modeling, Simulation and Fault Identification by Amalendu Mukherjee, Ranjit Karmakar, Arun Kumar Samantaray. I.K.International Publishing House Pvt. Ltd.

LECTUREWISE PROGRAMME : (from 08.01.18 to 27.04.18)

Introduction of the subject (08.01.18)	1
UNIT- I	
INTRODUCTION (10.01.18- 09.02.18)	
System Model, State-Determined system	3
Dynamic Models, Linear and nonlinear system,	3
Engineering Multi ports, Ports, Bonds, Power, Bond Graph,	2
Basic 1-Port, 2-Port elements, 3-Port Junction elements,	3
Causality and Block Diagram, Pseudo-Bond Graph	2
Modeling of Mechanical, Electrical and Thermal system	3
UNIT- II	
STATE SPACE EQUATIONS AND AUTOMATED SIMULATION (12.02.18-28.02.18)	
Standard form of system equations, Augmenting the bond graph	4
Basic formulation and reduction, deriving system equations from the bond graph model	5
UNIT – III	
LINEAR SYSTEM ANALYSIS (01.03.18- 02.04.18)	
Solution Techniques for Ordinary differential equations, Free response and Eigenvalue of first order, second order, undamped and damped oscillator	4
Forced and Frequency response function,	3
Transfer function, Block diagram	4
UNIT – IV (04.04.18- 27.04.18)	
MULTI PORTS AND JUNCTION STRUCTURE	
Energy storing field, C-field, I-field, Mixed energy storing field, Resistive field	5
Modulated two ports elements, Junction structure, Multiport transformer	5

Home Assignments :4 –5 assignments are given during the semester.

Evaluation Procedure

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Chamber consultation hour: Any vacant period.

Note:

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3. The use of properties (water, air, steam etc) tables, heat transfer tables, charts is permitted

(Dr. Anil Kumar Narwal)

MEI 520B Reliability and Maintenance Engineering

L	T	P	Credits		
4	-	-	04	Sessional Marks:	25
				Theory Marks:	75
				Duration of Exams:	3 Hours

Course Objectives

- The objective of the course is to provide the students with the fundamental concepts, the necessary knowledge and the basic skills related to systems reliability and systems maintenance function.
- The course intends to expose the students to the concept of reliability and to help them to learn the techniques of estimating reliability and related characteristics of components/ systems.
- To expose the students to the necessary engineering techniques used for analyzing, planning and controlling maintenance systems
- To impart not only the working principles and design aspects, but emphasizes the economical aspects of various industrial processes.

Course Outcomes

- The students will be able to understand the reliability and maintenance function and its objectives and know how to prepare reports about the maintenance function
- Gain the necessary knowledge about the types of maintenance and know how to use them when design maintenance systems
- Gain the necessary knowledge about failure distributions and apply failure analysis techniques
- Estimate systems reliability both for the independent & dependent cases as well as related characteristics and design systems for better reliability
- Estimate systems maintainability as well as related characteristics and design systems for better maintainability
- Understand and apply different methods of maintenance workload analysis
- Gain the necessary knowledge about the maintenance resources planning and apply various planning techniques
- Know the different ways for scheduling maintenance works and know how to use them

Detailed Contents

	Course Contents	Hours
Unit-I	**Reliability (12 Hours)**	
	Reliability concepts, definitions and its applications	2
	Failure data analysis, Mean failure rate, mean time to failure (MTTF)	3
	Mean time between failures (MTBF), hazard rate,	2
	Bathtub curve	2
	Use of Weibull probability chart for assessing characteristic life, guarantee period	3
Unit- II	**System Reliability (12 Hours)**	
	Series, parallel and mixed configuration, Simple problems	2
	Reliability improvement techniques	2
	Pareto analysis-Design for reliability	2
	Redundancy unit and stand by redundancy	2
	Optimization of reliability	1
	Failure modes, Event Tree and Fault Tree analysis	3
Unit-III	**Maintenance (15 Hours)**	
	Introduction to maintenance engineering and concept of maintenance	1
	Maintenance Objectives and Functions	1
	Maintenance Organization and Administration of Maintenance Systems	1
	Need of planned maintenance	1
	Maintenance policies; Breakdown, time based maintenance	2
	Block replacement, age replacement and periodic replacement policy	2
	Corrective and Preventive maintenance	1
	Maintenance planning, Scheduled maintenance.	2
	Cost of maintenance versus Cost of equipment and production delays	2
	Inspection: Inspection intervals	1
	Inspection reports, card history system	1

Unit-IV	**Predictive Maintenance (13 Hours)**	
	Predictive maintenance and its importance	1
	Equipment used in predictive maintenance, Equipment wears records standards	3
	Computerized maintenance	1
	Total Productive Maintenance	2
	Methods of condition monitoring	2
	Non-destructive testing: Liquid Penetrate, Magnetic particles, Ultrasonic testing, and Vibration analysis, Oil analysis, Radiographic testing.	4

Text Books:

1. Reliability Engineering by A.W. Von, PHI, ND.
2. Mechanical Reliability by L.S. Srinath, Published by EWP.
3. Maintenance Planning and Control by Enthory Kelly, EWP-NWP, ND.

Reference Books:

1. Smith, D.J. Reliability, Maintainability and Risk; Practical methods for engineers,Butterworth-Heinemann, New Delhi, 2001
2. Dhillon, B.S. Maintainability, Maintenance and Reliability for Engineers, CRC Press 2006
3. Pham, H. Handbook of Reliability engineering, Springer Publication, 2003.
4. Dhillon, B.S. Engineering maintenance; a modern approach, CRC Press, 2002
5. Mobley, R.K. Maintenance Fundamentals, 2nd Edition, Butterworth-Heinemann, 2004
6. Brauer, R.L. Safety and Health for Engineers, John Wiley Sons, 2006
7. Reliability Maintenance and Risk, Elsevier Science and Technology Books, 1997

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