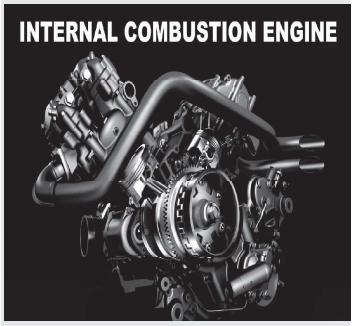
19ME331 INTERNAL COMBUSTION ENGINES



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Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	-	-	-

PRE-REQUISITE COURSE: Engineering Thermodynamics

COURSE DESCRIPTION AND OBJECTIVES:

This course offers fundamental knowledge of IC engines, working and combustion processes in SI and CI engines. It also provides knowledge on various fuel systems used in different engines. The objective of this course is to provide fundamental aspects of engines, thermodynamic cycles, and fuels, charging techniques, cooling systems and lubrication systems and their functions. It also provides knowledge on recent technological developments in fuel systems of SI and CI engines.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Evaluate the constructional and working principles of SI and CI engines.	1,2,4
2	Familiarize with modern technology in fuel system of SI and CI engines.	5,7
3	Analyze combustion of SI and CI engines.	2,4,5
4	Investigate the influence of combustion chamber design.	1,2,3
5	Understand the concepts and methods of turbo and super charging.	7

SKILLS:

- ✓ *Identify and appreciate the influence of fuel on engine performance.*
- ✓ *Select suitable engine for a given application.*
- ✓ *Evaluate combustion and emission characteristics.*
- ✓ *Design and analyze a fuel supply system.*
- ✓ *Differentiate different engine constructions.*

UNIT - I **L-9**

IC ENGINES: Introduction to IC engine, Basic engine components and nomenclature, Classification, Valve and Port timing diagrams.

COMBUSTION IN IC ENGINES: Introduction, Combustion in SI engine - stages of combustion, phenomenon of knock; Combustion in CI engine - stages of combustion, phenomenon of knock in CI engine.

UNIT - II **L-9**

FUELS & EMISSIONS: Availability and properties of conventional fuels, Octane number, Cetane number, Knocking and detonation, anti-knock agents, Biofuels - various vegetable oils for engines, Esterification, Performance in engines, Emission characteristics of SI and CI engines, Emission norms, Bio diesel and its characteristics.

UNIT - III **L-9**

FUEL SUPPLY SYSTEM IN S.I. & CI ENGINES: Principle of Carburetion, Mixture requirements, Gasoline injection - direct, port, manifold injection, Electronic fuel injection system; Requirements & types of diesel injection systems, Fuel injection pumps, Injectors, Governor - Mechanical, Pneumatic; Common rail fuel injection, Electronic injection system, Supercharging and turbocharging.

IGNITION SYSTEMS: Components, Magneto, Battery and Electronic ignition systems.

UNIT - IV **L-9**

LUBRICATION SYSTEM: Mechanical friction, Factors affecting friction, Pumping losses, Blow by losses, Lubrication of engine components, Lubricating systems.

COOLING SYSTEM: Temperature distribution of engine components, Need of cooling system, Air cooling, Liquid cooling, Types, Comparison.

UNIT - V **L-9**

HYBRID AND ELECTRIC VEHICLES: Introduction, Hybrid Electric Drive-trains, Electric Drive-trains, Electric Propulsion unit, Energy Storage, Matching the electric machine and the internal combustion engine.

TEXT BOOKS:

1. V. Ganesan,"Fundamentals of Internal Combustion Engines", 3rd edition, Tata McGraw-Hill, 2012.
2. Heywood J.B, "Internal Combustion Engine Fundamentals", 2nd edition, McGraw-Hill, 2002.

REFERENCE BOOKS:

1. H. N. Gupta, "Fundamentals of Internal CombII Year I SemesterII Year I SemesterII Year I Semesterustion Engines", 2nd edition, PHI Learning, 2012.
2. Gill P. W., Smith J. H. and Zurich E. J., "Fundamentals of I. C. Engines", 3rd edition, Oxford and IBH Pub. Co.,1999.

19ME332 3D PRINTING AND DESIGN

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
30	30	-	-	-	5

Source:
https://www.google.com/search?q=3d+printing+and+design

PRE-REQUISITE COURSE: Manufacturing Technology

COURSE DESCRIPTION AND OBJECTIVES:

This course offers advanced concepts of additive manufacturing techniques in 3D printing. The objective of this course to make students understand various rapid prototyping technologies and to select appropriate technologies for product development purposes.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the principles of various near-net manufacturing methods.	1
2	Select appropriate 3D printing technique for a desired end product.	1,2
3	Evaluate various 3D printing techniques with respect to quality of product.	2
4	Analyze the effect of process parameters on end products.	2

SKILLS :

- ✓ *Develop rapid prototypes to reduce product development time.*
- ✓ *Evaluate effect of process parameters in additive manufacturing.*
- ✓ *Design and produce models using 3D printing technology.*
- ✓ *Implement RPT technique in design and manufacturing of models.*

UNIT- I **L-9**

INTRODUCTION: Need for the compression in product development, Comparison with conventional manufacturing, History of 3D printing technology, Applications, Classification of RP systems.

UNIT- II **L-9**

RP PROCESS (LIQUID TYPE): Principle, Product design and development, Process parameters, Process details and applications of Stereolithography systems, Solid Ground Curing, Liquid Thermal Polymerization (LTP), Beam Interference Solidification (BIS).

UNIT- III **L-9**

RP PROCESS (SOLID TYPE): Principle, Process parameters, Process details and applications of Laminated object Manufacturing, Fused Deposition Modeling, Ballistic Particle Manufacture (BPM), Product design for LOM, FDM and BPM.

UNIT- IV **L-9**

RP PROCESS (POWDER TYPE): Principle, Process parameters, Process details and applications of Laser Engineered Net Shaping, 3DPrinting, Selective Laser Sintering, Product design.

UNIT- V **L-9**

RP PROCESS OPTIMIZATION: Rapid Manufacturing Process, Rapid Manufacturing process optimization, Factors influencing accuracy, Data preparation errors, Part building errors, Errors infinishing, Influence of part build orientation.

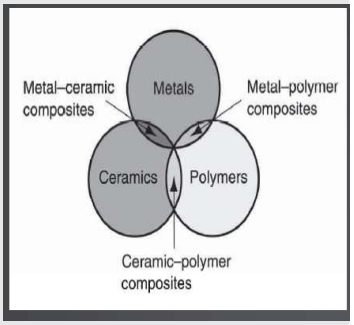
TEXT BOOKS:

1. Pham D T and Dimov S S, “Rapid Manufacturing”, Verlag, 2001.
2. Paul F Jacobs, “Stereo Lithography and other RP&M Technologies”, SME, 1996

REFERENCE BOOKS:

1. Terry Wohlers, “Wohlers Report 2001”, Wohlers Associates, 2008.
2. William H Philips, “Additive manufacturing: opportunities, challenges, implications” Nova science publishers, 2016.

19ME333 CERAMICS AND POLYMERS



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https://www.google.com/search?q=ceramics+and+polymers

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
30	30	-	-	-	5

PRE-REQUISITE COURSE: Materials Science and Metallurgy

COURSE DESCRIPTION AND OBJECTIVES:

This course offers basic knowledge on structures, properties, processing and applications of ceramics and polymers. The objective of this course is to impart knowledge on types of ceramics, bonding, functions, defects, polymerization and fabrication techniques.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Classify ceramics, polymers based on types of bonding and structures.	2
2	Analyze defects in ceramics and their effects on various properties.	2
3	Recognize polymerization methods for thermoplastics, thermosets and elastomers.	1
4	Describe the selection criteria of polymers for engineering applications.	3
5	Select a suitable processing method for different kinds of plastics.	5

SKILLS:

- ✓ *Identify various types of ceramics.*
- ✓ *Process ceramics by using different fabrication methods.*
- ✓ *Calculate coordination number of ceramic crystal structures.*
- ✓ *Utilize various properties of ceramics for desired application.*

UNIT- I **L-9**

INTRODUCTION TO CERAMICS: Ceramics as a class of engineering materials, Overview of properties, Classification of ceramics, Ceramic raw materials and their characteristics.

UNIT- II **L-9**

IONIC AND COVALENT BONDING: Variations in properties as a function of bonding, Crystalline and non-crystalline ceramics, Concept of co-ordination number, Ratio of ionic radii and corresponding crystal structures, Silicates.

UNIT- III **L-9**

PROPERTIES OF CERAMICS: Defects in crystalline ceramics, Non-stoichiometry, Glasses - types, structure; Bridging and non-bridging oxygen, Commercial oxide glasses and correlation of properties with structure, Mechanical properties and testing.

UNIT- IV **L-9**

INTRODUCTION TO POLYMERS: Introduction as a material, Classification, Types of polymerization, Molecular weight determination.

PLASTICS: Compounding of plastics, Properties with reference to important engineering plastics - LDPE, HDPE, PVC, polyester, phenol formaldehyde, epoxy, alkyds, cellulose and elastomers.

UNIT- V **L-9**

MANUFACTURING METHODS: Fabrication technology and polymer processing, Moulding practices.

APPLICATIONS: Elastomers, Adhesives, Bio-medical, Fibre reinforced plastics, Conducting polymers.

TEXT BOOKS:

1. Kingery W. D., Bowen H. K. and Ulhmen D. R., “Introduction to Ceramics”, 2nd edition, John Wiley, 1976 .
2. Billmeyer F., “Textbook of Polymer Science”, 3rd edition, Wiley Inter science, 1994.

REFERENCES BOOKS:

1. Richerson D. W., “Modern Ceramic Engineering - Properties, Processing and Use in Design”, 3rd edition, Marcel Deckker, 2005.
2. Norton F. H., “Elements of Ceramics”, 2nd edition, Addison Wesley, 1974.

19ME334 INDUSTRIAL ENGINEERING & ESTIMATING AND COSTING

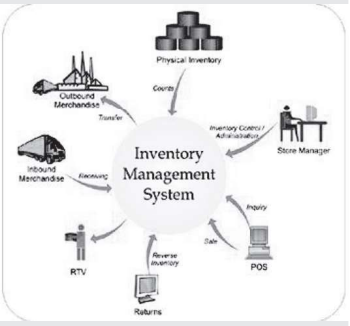
Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	15	10	-	3



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COURSE DESCRIPTION AND OBJECTIVES:

This course offers the application of principles and techniques for planning and control of the production and service systems to optimize/make best use of resources. The objective of this course is to emphasize the importance of various production planning control parameters and their applications used in industries.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the fundamental concepts of work study such as method study and work measurement.	1
2	Apply various types of engineering work measurement techniques. Such as time study, work sampling in analyzing time of tasks	1
3	Solve problems under different methods of depreciation.	2
4	Analyze various concepts of cost and revenue and apply break even analysis in real situation.	2
5	Implement the fundamental concepts of cost & estimation to determine the selling price various components.	4

SKILLS:

- ✓ *Perform break even analysis to calculate break even quantity.*
- ✓ *Implement the procedure of cost estimation in practical situations.*
- ✓ *Estimate the production cost of a given component produced in foundry shop, forging shop & welding shop.*
- ✓ *Evaluate the machining time for different operations performed in lathe, shaping, drilling, boring & grinding.*

UNIT- I **L-9**

WORK STUDY: Introduction, advantages.

METHOD STUDY: Definition, Objectives, Procedure, Recording Techniques, Outline process chart, Flow process chart, Two-handed process chart.

TIME STUDY: Definition, Objectives, Procedure, Simple numerical problems on standard time calculation, Simple numerical problems on work sampling - number of observations to be considered.

UNIT- II **L-9**

DEPRECIATION: Introduction, Purpose, Methods for calculating depreciation - straight line method, sum of year digit method, sinking fund method, machine hour basis method, numerical problems.

BREAK EVEN ANALYSIS: Introduction, Assumptions in break-even analysis, Important terms and definitions, Calculation of break-even point, Applications and limitations, Numerical problems.

UNIT- III **L-9**

ELEMENTS OF COST: Material cost, Labour cost and expenses, Total cost, Allocation of overheads by different methods, Numerical problems.

FUNDAMENTALS OF ESTIMATION: Purpose and Functions of estimating, Constituents of estimation, Differences between costing and estimating, Estimation of the selling price of a component - simple numerical problems.

UNIT- IV **L-9**

MENSURATION: Important formulae for various geometric shapes to calculate areas & volumes of components.

ESTIMATION OF THE WEIGHT AND COST OF MATERIAL REQUIRED FOR A PRODUCT: Divide the component drawing into simple and smaller geometrical configurations, Calculate the volumes and the weights of the material required, Estimation of cost of material, Numerical problems.

UNIT- V **L-9**

ESTIMATION OF MACHINING TIME: Estimation of time required for machining operations like turning, screw cutting, drilling, shaping, boring, grinding, numerical problems.

ESTIMATION OF FABRICATION COST: Use tables for obtaining consumption of gas, filler rods, and rate of welding for different types of welding, Estimate the cost of fabrication, Simple numerical problems.

ESTIMATION OF FORGING AND FOUNDRY COSTS: Simple numerical problems.

TEXT BOOKS:

1. T.R. Banga and S.C.Sharma, “Mechanical Estimating and Costing”, 17th edition, Khanna Publishers, 2001.
2. N.K. Agarwal, S.C. Sharma, T.R. Banga, “Industrial Engineering & Management Science”, 13th edition, Khanna Publishers, 2011.

REFERENCE BOOKS:

1. O.P.Khanna, “Industrial Engineering and Management”, Dhanpat Rai publishers, 2010.
2. G.B.S. Narang and V.Kumar, “Production and Costing”, Khanna Publishers,1995.

19ME335 ARTIFICIAL INTELLIGENCE FOR MECHANICAL ENGINEERS

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	30	-	5	-	3

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https://www.google.com/search?q=artificial+intelligence

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamentals of soft computing techniques and their applications in Mechanical Engineering. The main objective of this course is to make students conversant with the various machine learning artificial intelligence algorithms and soft computing techniques their application in context with Mechanical Engineering.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the significance and domains of Artificial Intelligence and knowledge representation.	1
2	Develop neural networks and related learning Algorithms.	2
3	Apply knowledge based algorithms for real time problems.	1
4	Formulate solutions to various mechanical engineering problems using appropriate optimization algorithms.	2

SKILLS:

- ✓ *Apply the appropriate artificial intelligence technique for solving problems.*
- ✓ *Decide whether neural network or fuzzy logic to use based on end application.*
- ✓ *Develop the adaptive based algorithms for optimized solutions.*
- ✓ *Estimate errors of AI technique from predicted and actual values.*

UNIT- I **L-9**

ARTIFICIAL INTELLIGENCE: Introduction to artificial intelligence, Evolution of AI, Application areas, Advantages, Limitations, Future applications, Semantic nets and description matching, Generate and test, Means-Ends analysis and problem eduction, Nets, Basic Search and optimal search, Trees and adversarial search, Rules and rule chaining, Planning.

UNIT- II **L-9**

INTRODUCTION TO NEURAL NETWORKS: Biological foundations, ANN models, Types of activation functions, Network architectures - introduction, Multilayer feed forward network (MLFFN), Radial basis function network (RBFN), Recurring neural network (RNN).

LEARNING ALGORITHMS: Learning process - supervised and unsupervised learning; Single layer and multiplayer perceptrons, Least mean square algorithm, Back propagation algorithm, Applications in forecasting and pattern recognition.

UNIT- III **L-9**

INTRODUCTION TO FUZZY LOGIC: Fuzzy sets, Fuzzy relations, Fuzzy conditional statements, Fuzzy rules, Fuzzy algorithm.

FUZZY LOGIC CONTROL SYSTEM: Fuzzy logic controller, Fuzzification interface, Knowledge base, Decision making logic, Defuzzification interface, Design of fuzzy logic controller, Case study.

UNIT- IV **L-9**

NEURO-FUZZY LOGIC CONTROL: Optimisation of membership function and rules base of fuzzy logic controller using neural networks, Genetic algorithm, Fuzzy neuron, Adaptive fuzzy systems, Case study.

UNIT- V **L-9**

NON – TRADITIONAL OPTIMIZATION ALGORITHMS: Genetic Algorithm - introduction, GA operations; Standard method, Rank method, Rank space method, Simulated annealing, Introduction to annealing - process, simulated annealing optimization; Particle swarm optimization - introduction, Particle swarm optimization.

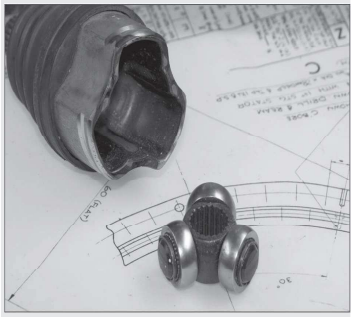
TEXT BOOKS:

1. Jacek.M. Zurada, “Introduction to artificial Neural Systems”, Jaico Publishing House, Mumbai, Digitized 2007.
2. Pratihar D.K., ”Soft Computing”, Narosa Publishers, 2015.

REFERENCE BOOKS:

1. Tsoukalas.L.H and Robert E. Uhrig., “Fuzzy and Neural approach in Engineering”, John Wiley and Sons, New York, 1997.
2. Klir.G.J and Yuan.B.B, “Fuzzy sets and fuzzy logic”, Prentice Hall of India, New Delhi, 1997.
3. Driankov.D, Hellendron.H and Reinfrank.M, “An Introduction to Fuzzy control”, Narosa publishing House, New Delhi, 1996.
4. Simon Haykins, “Neural Networks - A comprehensive foundation”, Macmillan College, Proc. Con. Inc. New York, 1994.

19ME336 TRIBOLOGY IN DESIGN



Source:
https://www.google.com/search?q=tribology+in+design

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	30	-	5	-	3

PRE-REQUISITE COURSES: Engineering Mechanics,
Mechanics of Fluids and Hydraulic Machines

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the factors affecting tribological features by friction, wear and lubrication between contact surfaces. The objective of this course is to impart importance of the lubrication to overcome friction and wear for improving the over-all performance of the machines

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the tribological system and factors affecting tribological phenomenon.	1
2	Predict the performance and behavior of a tribological system.	1
3	Estimate the critical operating speeds for avoiding oil whip and oil whirl.	2
4	Design efficient and robust tribological systems.	2

SKILLS:

- ✓ *Understand the nature of engineering surfaces and their topography.*
- ✓ *Identify the consequences of wear mechanisms.*
- ✓ *Analyze the principles of boundary lubrication and hydrodynamic theories.*
- ✓ *Apply the basic theories of friction, wear and lubrication to sliding and roller bearings.*

UNIT – I **L-9**

INTRODUCTION: Tribology in design, Tribology in industry, Viscosity, Flow of fluids, Viscosity and its variation, Absolute and kinematic viscosity, Temperature variation, Viscosity index determination ofviscosity, Different viscometers, Tribological considerations nature of surfaces and their contact, Physic, Mechanical properties of surface layer, Geometrical properties of surfaces, Methods of measuring surface roughness.

UNIT - II **L-9**

FRICTION: Role of friction and laws of static friction, Causes of friction, Theories of friction, Laws of rolling friction, Friction of metals and non-metals, Friction measurements.

WEAR: Definition of wear, Mechanism of wear, Types and measurement of wear, Friction affecting wear, Wear of metals and non-metals.

UNIT - III **L-9**

HYDROSTATIC LUBRICATION: Principle of hydrostatic lubrication, General requirements of bearingmaterials, Types of bearing materials, Hydrostatic step bearing, Hydrostatic lift, Hydrostatic squeeze film Bearing.

UNIT - IV **L-9**

HYDRODYNAMIC LUBRICATION: Principle of hydrodynamic lubrication, Petroff's equation, Reynold's equation in two dimensions, Friction in sliding bearing, Hydro dynamic theory applied tojournal bearing, Minimum oil film thickness, Oil whip and whirl, Anti-friction bearing, Hydrodynamic thrust bearing.

UNIT - V **L-9**

LUBRICANTS: Functions of lubricants, Types of lubricants and their industrial uses, SAE classification, Recycling, Disposal of oils, Properties of liquid and grease lubricants, Lubricant additives, General properties and selection.

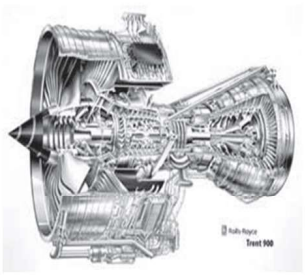
TEXT BOOKS:

1. Stachowiak, "Engineering Tribology", 4th edition, Paperback, Elsevier, 2015.
2. Prasanta Sahoo, "Engineering Tribology", 1st edition, PHI Learning Pvt. Ltd, 2011.

REFERENCES BOOKS:

1. Bowden F.P. and Tabor D., "The Friction and Lubrication of Solids", Oxford University Press, 2001.
2. Moore D.F, "Principles and Application of Tribology", 2nd edition, Pergamon Press, 1985.

19ME337 JET AND ROCKET PROPULSION



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Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	-	-	5

PRE-REQUISITE COURSE: Engineering Thermodynamics

COURSE DESCRIPTION AND OBJECTIVES:

This course offers a basic understanding on working of various air breathing and rocket engines. The objective of this course is to familiarize with basic working of different jet and rockets, missiles its performance parameters and applications.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Describe the working of air craft engines and rockets.	1,2
2	Solve the thermodynamic processes in practical applications.	2,3
3	Determine the efficiencies and performance of propulsion systems.	2,3,4
4	Distinguish various rocket and missile propulsion technologies.	1,2,3
5	Formulate equations to improve performance of a given system.	2,3

SKILLS:

- ✓ *Classify different air compressors and its applications*
- ✓ *Understand working principles of different turbo jet engines*
- ✓ *Differentiate liquid and solid propellant rocket engines and its applications*
- ✓ *Compare performance of different jet and rocket engines*
- ✓ *Demonstrate the working of advanced rocket and missiles.*

UNIT- I **L 9**

INTRODUCTION: Introduction to turbo machinery, working principles, applications.

CENTRIFUGAL COMPRESSORS: Principle of operation, Velocity and Pressure variation, Energy transfer, Impeller blade shape, Losses - slip factor, power input factor, pressure coefficient velocity diagrams, power.

AXIAL FLOW COMPRESSORS: Mechanical details and principle of operation, Velocity triangles and energy transfer per stage, Degree of reaction, Work done factor - isentropic efficiency, polytropic efficiency.

UNIT- II **L 9**

JET PROUPULSION: Classification of jet propulsive engines, Working Principles with schematic diagrams and representation on T.S. diagram, Thrust, Thrust Power and Propulsion Efficiency of Turbo jet engines, Thermodynamic Cycle, Turbo prop, Turbo fan, Ramjet, Pulse jet, Scram jet, Performance Evaluation, Thrust Augmentation Methods.

UNIT- III **L 9**

ROCKET PROPULSION: Application, working Principle, Classification, Propellant Type, Thrust, Propulsive Efficiency - characteristic velocity, thrust coefficient, specific Impulse; Solid and Liquid propellant, Rocket Engines, Salient features of solid propellant rockets, Selection criteria of solid propellants, Propellant grain design considerations, Salient features of liquid propellant rockets, Selection of liquid propellants, Various feed systems and injectors for liquid propellant rockets.

UNIT- IV **L 9**

ADVANCED ROCKET PROPULSION: Introduction to hybrid rocket propulsion, Standard and reverse hybrid systems, Combustion mechanism in hybrid propellant rockets, Applications and limitations of electric powered, nuclear powered, solar powered rocket engines.

UNIT- V **L 9**

MISSILES: Different types of Missiles and their Characteristics, Different Types of controls and their Merits / demerits, Major components of Missiles and their contributions, Preliminary estimates of forces on Missiles.

TEXT BOOKS:

1. Cohen.H, Rogers.G.F.C. and Saravanamuttoo.H.I.H, “Gas turbine theory”. 5th edition, Pearson education, 2001.
2. V.Ganesan., “Gas Turbines”, 3rd edition,Tata McGraw-Hill Education, 2010.
3. Chin, S. SMissile “Aerodynamics”, 1st edition, Tata McGraw-Hill Education, 1961.

REFERENCE BOOKS:

1. Sutton, G.P., “Rocket Propulsion Elements”, 5th edition, John Wiley & Sons Inc., New York, 1993.
2. Mathur, M.L., and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers and Distributors, Delhi, 1988.

19ME338 METROLOGY AND SURFACE ENGINEERING

source:
https://www.google.com/search?q=metrology+and+surface+engineering

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	8	5	-

PRE-REQUISITE COURSE: Machine Drawing

COURSE DESCRIPTION AND OBJECTIVES:

This course offers knowledge on limits, gauges, linear and angular measurements in engineering applications and also covers the aspects of surface engineering. The objective of this course is to develop knowledge of industrial measuring instruments and to select suitable surface treatment method to improve surface properties.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the tolerances, fits and surface quality.	2
2	Select and use appropriate methods and instruments for inspection of various linear, angular and surface measurements.	1,8
3	Evaluate various surface roughness parameters.	1,8
4	Analyze quality of surface coating technologies in industry.	2,8

SKILLS:

- ✓ *Design limits, fits and tolerances for the two mating parts.*
- ✓ *Analyse the precision and accuracy various products.*
- ✓ *Make Inspection process easy in mass production by selecting proper instruments.*
- ✓ *Create a product that can able to withstand friction and wear for long time.*
- ✓ *Improve the life of machine components by selecting appropriate coatings.*

UNIT-I **L-9**

INTRODUCTION TO METROLOGY: Product tolerance, Theory of limits, Fits and Tolerances, Fundamental deviation and types, Grades of tolerances, Fits - types of fits; Hole basis and shaft basis systems, Interchangeability and selective assembly, Limit Gauges, Taylor's principle, GO and NO GO gauges, Plug and Ring gauges.

UNIT- II **L-9**

LINEAR AND ANGULAR MEASUREMENTS: Slip gauges, Dial indicators, Micrometer, CMM, Angle and Taper measurement: Bevel protractor, Angle slip gauges, Sine bar, Taper determination using Rollers and spheres, Optical Measurements: Optical flats, NPL Interferometer.

UNIT- III **L-9**

COMPARATORS: Mechanical, Electrical, Pneumatic.

SURFACE ROUGHNESS MEASUREMENT: Surface roughness and surface texture, Numerical assessment of surface finish - CLA, RMS, Ten point height of irregularity; Measuring Instruments - Profilograph, Talysurf.

UNIT- IV **L-9**

SURFACE ENGINEERING: Surface texture and properties, Surface cleaning techniques, Surface integrity, Wear and its measurement, Lubricants and its selection for reducing wear, Principles of corrosion and remedial measures, Laser applications for surface modifications.

UNIT- V **L-9**

SURFACE TREATMENT: Mechanical surface treatment and coating, Casehardening and surface coating, Thermal spraying, Vapour deposition, Diffusion coating, Electroplating, Electrolysis plating and Electro formatting, Ceramic, organic and diamond coating.

TEXT BOOKS:

1. D.S. Kumar, "Mecahnical Measurements & Controls", 5th edition, Metropolitan Book, 2012.
2. R.K. Jain,"Engineering Metrology", 20th edition, Khanna Publishers, New Delhi, 2009.
3. M.Mahajan, "A Textbook Of Metrology" 2nd reprint edition, Dhanpat Rai & Co., New Delhi, 2014

REFERENCE BOOKS:

1. R.K. Rajput, "Mechanical Measurements & Instrumentation", 3rd edition, S.K. Kataria & Sons, 2010.
2. E.O. Doebelin, "Measurement Systems", 6th edition, Tata McGraw Hill, New Delhi, 2011.

19ME433 MICRO-ELECTRO MECHANICAL SYSTEMS

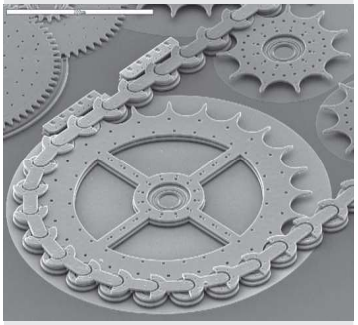
Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
15	30	-	5	-	3



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https://www.google.com/search?q=MICRO-ELECTRO+MECHANICAL+SYSTEMS

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamental concepts, types and applications of MEMS. The objective of this course is to impart knowledge about using MEMS in building sensors that aid automation and robotic systems in modern industrial scenario.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the operations of micro devices, micro systems and their applications.	1
2	Propose appropriate sensor based on end application.	1
3	Manipulate the sensor parameters as per requirement.	2
4	Design the micro devices, micro systems using the MEMS fabrication process.	2

SKILLS:

- ✓ *Attain knowledge on the applicability of MEMS.*
- ✓ *Apply relevant sensor as per requirement.*
- ✓ *Aalibrate the sensor parameters as per end application.*
- ✓ *Operate instruments works on the principle of MEMS.*

UNIT- I **L-9**

INTRODUCTION: Intrinsic characteristics of MEMS, Energy domains and Transducers, Sensors and Actuators, Introduction to Micro fabrication, Silicon based MEMS processes, New Materials, Review of electrical and mechanical concepts in MEMS, Semiconductor devices, Stress and strain analysis, Flexural beam bending,Torsional deflection.

UNIT- II **L-9**

SENSORS AND ACTUATORS-I: Electrostatic sensors, Parallel plate capacitors, Applications, Inter-digitated finger capacitor, Comb drive devices, Micro grippers, Micro motors, Thermal sensing and actuation, Thermal expansion, Thermal couples, Thermal resistors, Thermal bimorph, Applications, Magnetic actuators, Micromagnetic components, Case studies of MEMS in magnetic actuators, Actuation using Shape memory alloys.

UNIT- III **L-9**

SENSORS AND ACTUATORS-II: Piezoresistive sensors, Piezoresistive sensor materials, Stress analysis of mechanical elements, Applications to Inertia, pressure, tactile and flow sensors; Piezo, Electric sensors and actuators, Piezoelectric effects, Piezoelectric materials, Applications to inertia, acoustic, tactile and flow sensors.

UNIT- IV **L-9**

MICROMACHINING: Silicon anisotropic etching, Anisotropic wet etching, Dry etching of silicon, Plasma etching, Deep reaction ion etching (DRIE), Isotropic wet etching, Gas phase etchants, Case studies Basic surface micro machining processes, Structural and sacrificial materials, Acceleration of sacrificial etch, Striction and antistriction methods, LIGA process, Assembly of 3D MEMS, Foundry process.

UNIT- V **L-9**

POLYMER AND OPTICAL MEMS: Polymers in MEMS, Polimide, SU-8 -Liquid crystal polymer (LCP), PDMS, PMMA, Parylene, Fluorocarbon, Application to acceleration, Pressure, Flow and tactile sensors, Optical MEMS, Lenses and Mirrors, Actuators for active optical MEMS.

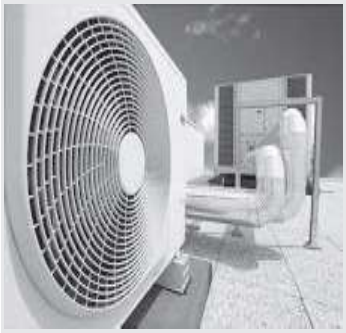
TEXT BOOKS:

1. Chang Liu, “Foundations of MEMS”, Pearson Education Inc., 2012.
2. Tai Ran Hsu, “MEMS & Micro systems Design and Manufacture”, Tata McGraw-Hill, New Delhi, 2002.

REFERENCE BOOKS:

1. NadimMaluf,”An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.
2. Mohamed Gad-el-Hak, editor, “The MEMS Handbook”, CRC press Baco Raton, 2001.
3. Julian W. Gardner, Vijay K. Varadan, Osama O.Awadelkarim, “Micro Sensors MEMS and Smart Devices”, John Wiley & Sons LTD, 2002.
4. James J.Allen, “Micro Electro Mechanical System Design”, CRC Press Publisher, 2005.
5. Thomas M.Adams and Richard A.Layton, “Introduction MEMS, Fabrication and Application,” Springer, 2010.

19ME434 REFRIGERATION & AIR CONDITIONING



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Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
5	40	-	-	-	-

PRE-REQUISITE COURSE: Engineering Thermodynamics

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the Psychrometry and various types of Refrigeration and Air conditioning systems used for both domestic and industrial needs. The objective of this course is to impart knowledge about air and vapour compression refrigeration systems.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Evaluate and analyze different refrigeration cycles.	1,2
2	Investigate various methods of improving the performance of R & AC systems.	5
3	Differentiate various types of refrigerants based on their environmental impact apart from usage.	7,8
4	Estimate various psychrometric properties using analytical and graphical techniques.	1,2,5
5	Develop various real time industrial and societal applications of Refrigeration and Airconditioning, particularly in food storages and malls.	3,7

SKILLS:

- ✓ *Design an Air conditioning equipment for specific cooling load.*
- ✓ *Determine the effective temperature and load with respect to outside ambient parameters.*
- ✓ *Design and analyse of various types Air conditioning equipment.*
- ✓ *Develop suitable air-conditioning systems for summer, winter as well as year-round applications.*
- ✓ *Analyze and estimates the C.O.P of various refrigerators.*
- ✓ *Operating and maintaining of air-conditioning units for various applications (i.e both domestic and industrial).*

UNIT- I **L-9**

INTRODUCTION TO AIR REFRIGERATION: Reversed Carnot cycle, Classification of refrigeration systems, Refrigerants classification, Nano Refrigerants and their mixtures - properties and characteristics; Ozone depletion and global warming issues, System components.

UNIT- II **L-9**

VAPOUR COMPRESSION SYSTEM(VCR): Performance, Coefficient of Vapour compression cycle and the types of compression processes, Actual cycle analysis, Two stage refrigeration systems, Influence of various parameters on system performance, Problems - use of P-H charts; System components - compressors, condensers, expansion devices and evaporators; Performance matching of components of refrigeration systems.

UNIT- III **L-9**

BASIC VAPOUR ABSORPTION SYSTEM: Ammonia absorption system, Analysis of NH_3 vapour absorption refrigeration and it's Coefficient of performance. Electrolux refrigeration system, Li - Br system - calculation of COP. Principle and operation of steam jet refrigeration system, Thermoelectric generator, Vortex tube or Hilsch tube**,** Adsorption refrigeration systems.

UNIT- IV **L-9**

PSYCHROMETRY: Properties and Processes, Need for Ventilation, Infiltration, Concepts of RSHF, ASHF, ESHF and ADP, Types of cooling loads, Cooling load calculations, Concept of human comfort and effective temperature, Comfort air conditioning, Industrial air conditioning and requirements, Year round air conditioning.

UNIT- V **L-9**

APPLICATIONS OF AC SYSTEMS: Concept of enthalpy potential, Air cleaning and filters, Humidifiers and dehumidifiers, Fans and Blowers, Grills and Registers, Heat pump-Air washers, Cooling towers.

TEXTBOOKS:

1. S.C. Arora & Domkundwar, "A Course in Refrigeration & Air-conditioning", 2nd edition, Dhanpath Rai and Sons, 2009.
2. Dossat. "Principles of Refrigeration", 2nd edition, Willey Eastern, 2006.

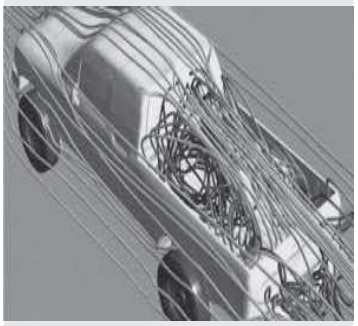
REFERENCEBOOKS:

1. C.P. Arora "Refrigeration& Air-conditioning", 3rd edition, Tata McGraw-Hill, 2009.
2. Manohar Prasad "Refrigeration& Air-conditioning", 2nd edition, New age publication, 2002.

DATA BOOK:

1. Kothandaraman C.P "Refrigeration tables and charts including air-conditioning data" 4th edition, New age publication, 2015

19ME435 COMPUTATIONAL FLUID DYNAMICS



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Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
5	30	-	-	-	-

PRE-REQUISITE COURSE: Mechanics of Fluids and Hydraulic Machines

COURSE DESCRIPTION AND OBJECTIVES:

This course offers basic understanding to solve and analyze problems involving fluid flow and heat transfer by using finite difference and finite volume methods. The objective of this course is to enable the students to formulate the interactionof fluids and gases with the surfaces for various initial and boundary conditions.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1`	Develop governing equations for fluid flow.	1,2
2	Apply appropriate boundary conditions for a given fluid flow problem.	1,2
3	Gain skills in the implementation of computational methods.	1,2,5
4	Formulate finite difference and finite volume methods for various fluid flow problems.	1,5,2
5	Assess stability of a given numerical scheme.	2,3

SKILLS:

- ✓ *Convert partial differential equations to linear algebraic equations.*
- ✓ *Solve linear equations using various numerical techniques.*
- ✓ *Analyze the fluid flow patterns and heat transfer phenomenon using various plots.*
- ✓ *Compare the results with available experimental results.*
- ✓ *Apply finite difference methods for various fluid flow problems*
- ✓ *Perform stability and grid-convergence analysis for a given numerical scheme.*

UNIT- I **L-9**

GOVERNING EQUATIONSAND BOUNDARYCONDITIONS: Basics of computational fluid dynamics, Definition and overview of CFD, Need, Advantages, Problem areas, Governing equations of fluid dynamics - continuity, momentum and energy equations; Physical boundary conditions.

UNIT- II **L-9**

PARTIAL DIFFERENTIAL EQUATIONS AND DISCRETIZATION: Mathematical behavior of PDEs in CFD - elliptic, parabolic and hyperbolic equations; Methods of deriving the discretization equations, Taylor series formulation, Introduction to finite difference method, Detailed treatment of finite difference method, Explicit and implicit methods, Errors and stability analysis, Convergence criteria.

UNIT- III **L-9**

FINITE DIFFERENCE METHODOLOGIES: Lax-Wendroff Technique, MacCormack's Technique, Space marching method, Direct and iterative methods, Thomas algorithm, Alternating direction implicit method.

UNIT- IV **L-9**

FINITE VOLUME METHOD: Finite volume formulation of steady and transient for one-dimensional and two-dimensional conduction equation, Source term linearization, Incorporating boundary conditions, Finite volume formulation of steady one-dimensional convection and diffusion problems.

UNIT- V **L-9**

FINITE VOLUME METHODOLOGIES: Central differencing, Upwind, Hybrid and power-law schemes, Representation of the pressure gradient term and continuity equation, Staggered grid-Momentum equations, Pressure and velocity corrections, Pressure correction equation, SIMPLE algorithm and its variants.

TEXT BOOKS:

1. Versteeg H.K. and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd edition, Longman Publication, 2007.
2. John D. Anderson Jr, "Computational Fluid Dynamics-The Basics with Applications", 6th edition, McGraw-Hill, 2009.

REFERENCE BOOKS:

1. C. Hirsch, "Numerical Computation of Internal and External Flows", Volumes I and II, 2nd edition, John Wiley and Sons, 2007.
2. Subhash V. Patankar, "Numerical heat transfer fluid flow", 2nd edition, Hemisphere Publishing Corporation, 2004.
3. Muralidhar K. and Sundararajan T., "Computational Fluid Flow and Heat Transfer", 2nd edition, Narosa Publishing House, New Delhi, 2011.

19ME436 CRYOGENICS

Source:
https://www.google.com/search

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
60	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	40	-	5	-	3

PRE-REQUISITE COURSES: Engineering Thermodynamics, Heat and Mass Transfer

COURSE DESCRIPTION AND OBJECTIVES:

This course offers fundamentals of cryogenics and their applications in various fields. The objective of the course is to impart knowledge on principles of cryogenics, various cryogenic systems, properties of fluids and materials at cryogenic temperatures. This course also provides knowledge on liquefaction of gases, separation and purification of gases, insulation systems, vacuum technology, instrumentation and safety in cryogenics.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Evaluate fluid and material properties at cryogenic temperature.	1,2,3,5
2	Analyze performance of cryogenics gas liquefaction system.	1,2,4,5,9
3	Differentiate the working of various cryogenics systems.	1,2,3,4, 5,6,9,10
4	Understand cryogenic fluid storage and applications of cryogenic systems.	1,2,4, 5,12
5	Demonstrate the knowledge on vacuum Technology and instrumentation in cryogenics.	1,2,3,5

SKILLS:

- ✓ *Identify and select suitable materials and fluids for cryogenic application.*
- ✓ *Ability to calculate figure of merit of liquefaction systems and effectiveness of cryogenic refrigeration systems.*
- ✓ *Evaluate the performance of gas separation and purification systems.*
- ✓ *Understanding of the insulation of cryogenic storage vessels and transportation of cryogenic fluids.*
- ✓ *Apply knowledge of vacuum technology in operation of cryogenic systems and instrumentation.*

UNIT- I **L-9**

FUNDAMENTALS OF CRYOGENICS: Introduction, Cryogenic temperature scale, Properties and uses of cryogenic fluids, Properties of materials at cryogenic temperature, Debye model of thermal conductivity.

UNIT- II **L-9**

GAS LIQUEFACTION SYSTEMS: Introduction, Production of low temperature, Liquefaction systems for Freon, Hydrogen and Helium, Cryo-coolers - Sterling, G-M and Pulse tube cry coolers.

UNIT- III **L-9**

GAS SEPARATION AND PURIFICATION SYSTEMS: Thermodynamically ideal separation systems, Properties of mixtures, Principles of gas separation - Linde single column and double column system of air separation.

UNIT- IV **L-9**

CRYOGENIC FLUID STORAGE AND TRANSFER SYSTES: Cryogenic fluid storage vessels Insulation, Cryogenic fluid transfer systems, Application of cryogenic systems - super conductive devices, cryogenic space technology, cryogenics in biology and medicine; Applications of refrigeration - industrial, comfort, food preservation, medical.

UNIT- V **L-9**

INSULATION AND INSTRUMENTATION: Cryogenic Insulations, Vacuum Technology, Instrumentation in Cryogenics, Safety in Cryogenics.

TEXT BOOKS:

1. Thomas M. Flynn, “Cryogenic Engineering”, CRC Press, 2004.
2. S. S. Thipse, “Cryogenics”, Alpha Science, 2013.

REFERENCE BOOKS:

1. Randall F. Barron, “Cryogenics Systems”, 2nd edition, Oxford Univesity Press New York, Clarendon Press, Oxford, 1985.
2. Timmerhaus, Flynn, “Cryogenics Process Engineering”, Plenum Press, New York, 2003.

19ME431 COMPOSITE MATERIALS TECHNOLOGY

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	30	-	-	-	5

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PRE-REQUISITE COURSE: Materials Science and Metallurgy

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the areas of composite materials its manufacturing, mechanics, design and inspection. The objective of this course is to impart knowledge on composite materials and its applications.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Classify composite materials based on the composition and constitution of the composite material.	1
2	Evaluate composite elastic properties based on micro/macro-mechanical behavior.	3
3	Propose a suitable material for typical engineering problems.	2
4	Identify the suitable manufacturing process for MMC.	2
5	Understand and categories the various manufacturing operation in the fabrication of FRP.	1

SKILLS :

- ✓ *identify the need of materials for engineering applications.*
- ✓ *knowledge on micro/macro-mechanical elastic behavior of composite materials.*
- ✓ *identify suitable materials for various application in engineering.*
- ✓ *will have an idea on selection of suitable manufacturing process.*
- ✓ *able to have basic knowledge on FRP.*

UNIT- I **L-9**

INTRODUCTION TO COMPOSITE MATERIALS: Definition, Classification and characteristics of composite Materials - fibrous composites, laminated composites, particulate composites; Applications, Future potential of composites.

CONSTITUENT MATERIALS IN COMPOSITES: Role and Selection of reinforcement materials, Types of fibers, Mechanical properties of fibers, Glass fibers, Carbon fibers, Aramid fibers, Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix, Fiber reinforced Polymer (FRP), Laminated composites, Lamina and Laminate Lay-up, Ply-orientation.

UNIT- II **L-9**

MACRO MECHANICS OF A LAMINA: Hooke's law for two-dimensional angle lamina, Engineering constants, Numerical problems, Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

MICRO MECHANICAL ANALYSIS OF A LAMINA: Introduction, Rule of mixtures - numerical problems.
MACRO MECHANICAL ANALYSIS OF LAMINATE: Introduction, Code, Kirchhoff hypothesis, CLT, A, B, and D matrices (Detailed derivation), Special cases of laminates.

UNIT- III **L-9**

CHARACTERIZATION OF COMPOSITES: Mechanical testing of composites - Tensile testing, Compressive testing, Intra laminar shear testing, Inter laminar shear testing, Fracture testing, Thermal testing; Environmental Effects on composite.

STRENGTH AND FAILURE THEORIES: Strength of Laminates Failure Mechanics of Composites, Macro mechanical failure theories - maximum stress theory, maximum strain theory, Tsai-Hill Theory, Tsai-Wu Theory; Comparison of Failure Theories.

UNIT- IV **L-9**

METAL MATRIX COMPOSITES: Reinforcement materials, Types, Characteristics and selection base metals selection, Need for production MMC's and its application.

FABRICATION PROCESS FOR MMC'S: Powder metallurgy technique, Liquid metallurgy technique, Diffusion bonding, Squeeze technique and secondary processing.

FABRICATION PROCESS FOR PMC'S: Hand Lay-up, Autoclave molding, Fiber-only performs, Wet Lay-up and Spray-up, Filament winding, Pultrusion, Resin Transfer Molding (RTM), Compounding, Injection molding.

UNIT- V **L-9**

JOINING OF COMPOSITES: Adhesives, Mechanical, Welding, Friction-fit integral joints. Various joining processes of FRP laminated composites.

RECYCLING OF COMPOSITES: Categories of scrap composites, Recycling methods for thermoplastic matrix composites and thermoset matrix composites.

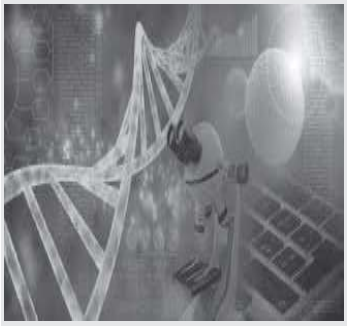
TEXT BOOKS:

1. Ronald F. Gibron, "Principles of composite Material mechanics", 3rd edition, McGraw-Hill international, 2011.
2. P. K. Mallick, "Fiber Reinforced Composites, Materials, Manufacturing, and Design", 3rd edition, CRC Press, 2007.

REFERENCE BOOKS:

1. Autar K. Kaw, "Mechanics of composite materials", 2nd edition, CRC Press NewYork, 2005.
2. K. K. Chawla, "Composite Science and Engineering", 3rd edition, Springer Verlag, 2012.

19ME437 NANOTECHNOLOGY



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Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
20	30	-	-	-	5

PRE-REQUISITE COURSE: Materials Science and Metallurgy

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with fundamentals of nanotechnology, domain applications and its implications. The objective of this course is to impart basics of nanotechnology in the integrated multidiscipline such as material science, medicine, electronics and space applications, etc.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the need of Nano materials and its applications.	1
2	Select a suitable synthesize technique for nano materials.	2
3	Identify the necessity of carbon Nano materials in engineering applications.	2
4	Apply domain specific knowledge of Nano technology.	1
5	Identify implication of nanotechnology.	2

SKILLS:

- ✓ *Need of nano materials for various applications.*
- ✓ *knowledge on synthesis of nano materials.*
- ✓ *Recognize domain applications of nanotechnology in textiles, space, medicine, computers and electronics.*
- ✓ *Explore various challenges of nanotechnology in real time applications.*

UNIT- I **L-9**

GENESIS OF NANOTECHNOLOGY: Introduction, Nano Science, Nano technology, Nano materials, Scope of applications, Properties of Nano materials, Basic principles of Nano science and technology Basics of quantum mechanics, Quantum Nano structures.

UNIT- II **L-9**

FABRICATION OF NANOMATERIALS: Introduction, Nano materials, Properties of Nano materials, Techniques used in Nano technology - top-down approach, bottoms-up approach; Tools used in nano technology - Electron Microscope, Atomic Force Microscope (AFM); Synthesis of Nano materials.

UNIT- III **L-9**

CARBON NANO MATERIALS(CNT): Introduction, Preparation, Properties, Classification, Fullerens, Applications of Carbon Nano Tubes, Carbon based nano composites.

UNIT- IV **L-9**

DOMAIN APPLICATION OF NANOTECHNOLOGY: Introduction, Applications of Nano technology in Environment and Energy - textiles, agriculture, electronics and communication, computers medicine, space technology.

UNIT- V **L-9**

PROJECTED USE AND IMPLICATIONS OF NANOTECHNOLOGY: Introduction, Assessment of opportunities, Bottlenecks in implementation of Nano technology, Exploration and Economical concerns of Nano technology, Current research activity.

TEXT BOOKS:

1. Mark Ratner, “Nano technology”, 3rd edition, Pearson Education, 2008.
2. ManasiKarkare, “Nanotechnology Fundamentals and Applications”, 1st edition, I.K. International Publishing House, 2008.

REFERENCE BOOKS:

1. T. Pradeep, “Nano the Essentials”, 3rd edition, McGraw-Hill, 2009.
2. A.K. Badyopadhyay, “Nano Materials”, 1st edition, New age International Publications, 2009.

19ME438 LEAN MANUFACTURING

https://www.google.com/search?tbm=isch

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
40	20	5	5	-	3

COURSE DESCRIPTION AND OBJECTIVES:

This course offers key concepts in lean manufacturing such as just-in-time production, “pull” philosophy and total quality management. This course also discusses different ‘lean’ tools and their significance in improving the workplace. The objective of this course is to design a globally competitive manufacturing organization using lean manufacturing principles, and to develop the skills to implement lean manufacturing in industry and manage the change process to achieve continuous improvement of efficiency and productivity.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Understand the concepts in Lean Manufacturing and preparation.	7
2	Analyzethe production process, tools and techniques of Lean Manufacturing.	3
3	Apply the issues of SMED in Lean implementation.	10
4	Discuss about issues in concurrent engineering.	6

SKILLS:

- ✓ *Identify the key requirements and concepts in lean manufacturing to initiate a continuous improvement change program in a manufacturing organization.*
- ✓ *Initiate a continuous improvement change program in a manufacturing organization.*
- ✓ *Apply the tools in lean manufacturing to analyze a manufacturing system and plan for its improvements.*
- ✓ *Manage the manufacturing system to achieve six sigma quality and sustainability.*

UNIT- I **L-9**

LEAN PRODUCTION: Introduction, Background and lean thinking, Importance of philosophy, strategy, culture, alignment, focus and systems view; Toyota Production System.

LEAN PRODUCTION PREPARATION: System assessment, Process and value-stream mapping, Sources of waste.

UNIT- II **L-9**

LEAN PRODUCTION PROCESSES, APPROACHES AND TECHNIQUES: Importance of focusing upon flow, Tools include - Workplace organization, 5S, Stability, Just-In-Time, One piece flow, Pull, Cellular systems, Quick change and set-up reduction methods, Total productive maintenance, Poka-Yoke-mistake proofing, quality improvement, Standards, Leveling and Visual management, Six Sigma.

UNIT- III **L-9**

SMED: Single minute exchange of dies, Theory and practice of the SMED system, The structure of production, Set-up operations, Fundamentals of SMED, Techniques for applying SMED, Basic examples of SMED.

UNIT- IV **L-9**

EMPLOYEE INVOLVEMENT: Teams, Training, Supporting and encouraging involvement - involving people in the change process, communication; Importance of culture.

UNIT- V **L-9**

CONCURRENT ENGINEERING: Obeya in Toyota's new product development process, Cross functional teams, Use of computer technology, Information management for simultaneous engineering.

TEXT BOOKS:

1. Liker J, "The Toyota Way", McGraw-Hill, 2015.
2. Liker J and Meier D, "The Toyota Way Field book", McGraw-Hill, 2016.

REFERENCE BOOKS:

1. Womack J and Jones D, "Lean Thinking", Free Press, 2011.
2. Dennis, P., "Lean Production Simplified", Productivity Press, 2010.
3. Shingo, S., "A Revolution in Manufacturing: The SMED System", Productivity Press, 2013.
4. Askin R G and Goldberg J B, "Design and Analysis of Lean Production Systems", John Wiley and Sons Inc., 2003.

19ME432 MAINTENANCE ENGINEERING

Source:
https://www.google.com/search?q=maintenance+engineering

Hours Per Week :

L	T	P	C
3	-	-	3

Total Hours :

L	T	P
45	-	-

WA/RA	SSH/HSH	CS	SA	S	BS
10	20	-	-	-	3

COURSE DESCRIPTION AND OBJECTIVES:

This course deals with the fundamental concepts, necessary knowledge and the basic skills related to systems maintenance function and its models for optimal preventive maintenance, replacement and inspection schedules.The objective of this course is to interpret the maintenance principles, strategies and models in real world industry.

COURSE OUTCOMES:

Upon completion of the course, the student will be able to achieve the following outcomes:

COs	Course Outcomes	POs
1	Apply the knowledge of maintenance engineering to work professionally in industrial systems.	1
2	Estimate systems maintenance as well as related characteristics of repairable systems for better maintainability.	2
3	Discuss various condition monitoring techniques in preventive maintenance.	1
4	Evaluate optimal maintenance times of an equipment for variety of maintenance conditions.	2,5

SKILLS:

- ✓ *Acquire the knowledge of principles of maintenance, statistics and optimal models to work professionally in industrial systems.*
- ✓ *Maintenance workload analysis and scheduling.*
- ✓ *Prepare maintenance resource planning.*
- ✓ *Computerized maintenance management systems (CMMS).*

UNIT- I **L-9**

INTRODUCTION: Objectives and principles of planned maintenance, Strategic, tactical and continuous improvements; Importance and benefits of sound Maintenance systems, Maintenance categories and Comparative merits of each category - Preventive maintenance, Total productive maintenance, Reliability centred maintenance, Maintenance organization, Maintenance economics.

UNIT- II **L-9**

COMPONENT REPLACEMENT DECISIONS: Introduction about replace of a component/system based on different parameters, Development of mathematical models for optimal replacement times of equipment based on maintenance and equipment cost, equipment subjected to break down (Group or block replacement policy) by considering times required for failure and preventive replacements; Real time industry application for each model.

UINT- III **L-9**

INSPECTION DECISIONS: Introduction, Mathematical models for optimal inspection frequency subjected to minimization of downtime, maximize the availability; Condition Based Maintenane (CBM) and its compatible software tools, Practical problems for each optimized model.

UNIT- IV **L-9**

CAPITAL EQUIPMENT REPLACEMENT DECISIONS: Introduction, Mathematical models for optimal replacement interval for capital equipment - minimization of total costs, maximization of discounted benefits by considering technological improvement with finite planning; Fleet maintenance problems for each variety.

UNIT- V **L-9**

REPAIRABLE SYSTEMS: Reliability and Machine availability, MTBF, MTTR and MWT, Factors of availability.

INTRODUCTION: Repairable system, Types of repairs - perfect, minimal and imperfec; Types of systems - independent identically distributed (i.i.d) and dependent.

RELIABILITY AND MAINTAINABILITY ESTIMATION OF REPAIRABLE SYSTEMS: Renewal process, Poission process for i.i.d systems, Homogenous Poission Process for perfect repair, Non-homogenous process for minimal repair and Kijima-I and kijima-II models for imperfect repair, Expected number of failure estimation for each variety.

TEXT BOOKS:

1. Andrew K.S. Jardine and Albert H.C. Tsang, “Maintenance, Replacement, and Reliability: Theory and Applications”, 2nd edition, CRC Press, 2013.
2. Elsayed A and Elsayed, “Reliability Engineering”, 2nd edition, John Wiley & Sons, 2012.

REFERENCE BOOKS:

1. John D. Campbell, Andrew K.S. Jardine and Joel McGlynn, “Asset Management Excellence: Optimizing Equipment Life-Cycle Decisions”, 2nd edition,CRC Press, 2016.
2 .B.S Dhillon, “Engineering Maintenance: A modern approach”, 1st edition, CRC Press, 2002.
3. Dimitri B. Kececioglu, “Maintainability, Availability & Operational Readiness Engineering Handbook, Volume 1”, 1st edition, DES*tech* Publications, 2003.
4. Riccardo Manzini, Alberto Regattieri, Hoang Pham and Emilio Ferrari “Maintenance for Industrial Systems”, Springer-Verlag London Limited, 2010.