

Semester – V: Departmental Elective – II: Specialization –

**DR. A. P. J. ABDUL KALAM TECHNICAL UNIVERSITY
LUCKNOW, UTTAR PRADESH**



STUDY & EVALUATION SCHEME WITH SYLLABUS

FOR

B. TECH. 3rd YEAR

MECHANICAL ENGINEERING

[Effective from Session: 2020-21]

MECHANICAL ENGINEERING

Syllabus Content of B. Tech Mechanical Engineering

SEMESTER- VI													
Sl. No.	Code	Subject	Periods			Evaluation Scheme				End Semester		Total	Credits
			L	T	P	CT	TA	Total	PS	TE	PE		
1	KME 601	Refrigeration and Air Conditioning	3	1	0	30	20	50		100		150	4
2	KME 602	Machine Design	3	1	0	30	20	50		100		150	4
3	KME 603	Theory of Machine	3	1	0	30	20	50		100		150	4
4		Departmental Elective-III	3	0	0	30	20	50		100		150	3
5		Open Elective-I	3	0	0	30	20	50		100		150	3
6	KME 651	Refrigeration and Air Conditioning Lab	0	0	2				25		25	50	1
7	KME 652	Machine Design Lab	0	0	2				25		25	50	1
8	KME 653	Theory of Machine Lab	0	0	2				25		25	50	1
9	KNC601/ KNC602	Constitution of India, Law and Engineering / Indian Tradition, Culture and Society	2	0	0	15	10	25		50			NC
10	Total		17	3	6						900	21	

It is suggested that the students should choose Departmental Electives Specializationwise that will support them to gain enough learning of the chosen Specialization.

Department Electives

	Specialization-1	Specialization-2	Specialization-3	Specialization-4	Specialization-5
Specialization	Manufacturing and Automation	Automation and Industry 4.0	Design and Analysis	Thermal Engineering	Automobile Engineering
Sem V Code	KME 051	KME 052	KME 053	KME 054	KAU 051
Departmental Elective-I	Computer Integrated Manufacturing	Mechatronics Systems	Finite Element Methods	I C Engine Fuel and Lubrication	Automobile Engines & Combustion
Sem V Code	KME 055	KME 056	KME 057	KME 058	KAU 052

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Semester – V: Departmental Elective – II: Specialization –

Departmental Elective-II	Advance welding	Programming, Data Structures And Algorithms Using Python	Mechanical Vibrations	Fuels and Combustion	Automotive chassis and suspension
Sem VI Code	KME 061	KME 062	KME 063	KME 064	KAU 061
Departmental Elective-III	Non destructive Testing	Artificial Intelligence	Tribology	Gas Dynamics and Jet Propulsion	Automotive Electrical and Electronics
Sem VII Code	KME 071			KME 072	KAU 072
Departmental Elective-IV	Additive manufacturing (Common to all Three Specializations)			HVAC systems	Hybrid Vehicle Propulsion
Sem VII Code	KME 073	KME 074	KME 075	KME 076	KAU 073
Departmental Elective-V	Mathematical Modeling of Manufacturing Processes	Machine Learning	Computer Graphics and product modeling	Power Plant Engineering	Vehicle Body Engineering & safety

It is suggested that the students may also do the following MOOCs in addition to mandatory courses. This will enhance their learning in a particular Specialization. One MOOC per semester is recommended.

Suggested MOOCs Course

Sp eci ali zat ion	Specialization -1	Specialization -2	Specialization -3	Specialization -4	Specialization -5
	Manufacturing and Automation	Automation and Industry 4.0	Design and Analysis	Thermal Engineering	Automobile Engineering
Sem V	Advance Machining Process https://swayam.gov.in/nd1_noc20_me76/preview By Prof. Manas Das, IIT Guwahati	Control Systems https://swayam.gov.in/nd1_noc20_ee90/preview By Prof. C. S. Shankar Ram, IIT Madras	Experimental Stress Analysis https://swayam.gov.in/nd1_noc20_me02/preview By Prof. K. Ramesh IIT Madras	Fluid dynamics and turbo machines https://swayam.gov.in/nd1_noc20_me75/preview By Prof. Dhiman Chatterjee, Prof. Shamit Bakshi, IIT Madras	Vehicle Dynamics https://nptel.ac.in/courses/107/106/107106080/ Prof P R Krishnakumar, IIT Madras

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Sem VI	Introduction to robotics https://swayam.gov.in/nd1_noc20_de11/preview By Prof. Asokan T, Prof. Balaraman Ravindran, Prof. Krishna Vasudevan, IIT Madras	Introduction to robotics https://swayam.gov.in/nd1_noc20_de11/preview By Prof. Asokan T, Prof. Balaraman Ravindran, Prof. Krishna Vasudevan, IIT Madras	Introduction to CFD https://swayam.gov.in/nd1_noc20_ae11/preview By Prof. Arnab Roy, IIT Kharagpur	Introduction to CFD https://swayam.gov.in/nd1_noc20_ae11/preview By Prof. Arnab Roy, IIT Kharagpur	Control Systems https://swayam.gov.in/nd1_noc20_ee90/preview By Prof. C. S. Shankar Ram, IIT Madras
Sem VII	Automation in Manufacturing https://swayam.gov.in/nd1_noc20_me58/preview By Prof. Shrikrishna N. Joshi, IIT Guwahati	Introduction to Industry 4.0 and Industrial Internet of Things https://swayam.gov.in/nd1_noc20_cs69/preview By Prof. Sudip Misra, IIT Kharagpur	Introduction to Composites https://swayam.gov.in/nd1_noc20_me95/preview By Prof. Nachiketa Tiwari, IIT Kanpur	Fundamentals of Compressible Flow https://swayam.gov.in/explorer?searchText=Compressible%20Flow By Prof. Niranjana Sahoo, IIT Guwahati	Introduction to hybrid and Electric Vehicles MOOC: https://nptel.ac.in/courses/108/103/108103009/ Dr. Praveen Kumar, Prof. S. Majhi, IIT Guwahati
Sem VIII	Production and Operation Management https://swayam.gov.in/nd1_noc20_mg06/preview By Prof. Rajat Agrawal, IIT Roorkee	Supply Chain management https://swayam.gov.in/nd2_cec20_mg11/preview By Dr. P. Chitramani, Avinashilingam Institute for Home Science and Higher Education for Women	Material Characterization https://swayam.gov.in/nd1_noc20_mm14/preview By Prof. Sankaran. S, IIT Madras	Computational Fluid Dynamics for Incompressible Flows https://swayam.gov.in/nd1_noc20_me06/preview By Prof. Amaresh Dalal, IIT Guwahati	Fuel Cell Technology https://nptel.ac.in/courses/103/102/103102015/ By Dr. Anil Verma, IIT Guwahati & Prof. S. Basu, IIT Delhi

Subject Code: KME 601		Refrigeration & Air Conditioning		L T P : 3 1 0	Credits: 4
The students will be able to					Blooms Taxonomy
CO1	Understand the basics concepts of Refrigeration & Air-Conditioning and its future prospects.				K2
CO2	Explain the construction and working of various components in Refrigeration & Air-Conditioning systems.				K2
CO3	Understand the different types of RAC systems with their respective applications.				K2
CO4	Apply the basic laws to the thermodynamic analysis of different processes involved in Refrigeration and Air-Conditioning.				K3
CO5	Apply the basic concepts to calculate the COP and other performance parameters for different RAC systems				K3
CO6	Analyze the effects of performance parameters on COP.				K4

Unit-1

8 Hours

Refrigeration:

Introduction to refrigeration system, Methods of refrigeration, Unit of refrigeration, Refrigeration effect, Carnot refrigeration cycle, Refrigerator and Heat Pump, C.O.P.

Air Refrigeration cycle:

Open and closed air refrigeration cycles, Reversed air Carnot cycle, Bell Coleman or Reversed Joule air refrigeration cycle, Need of Aircraft refrigeration, Classification of aircraft refrigeration system. Boot strap refrigeration, Regenerative, Reduced ambient, Dry air rated temperature (DART).

Unit-2

8 Hours

Vapour Compression System:

Reversed vapour Carnot cycle, limitation of Reversed vapour Carnot cycle, Simple vapour compression cycle, Analysis of vapour compression cycle, Use of T-S and P-H charts, Effect of change in suction and discharge pressures on C.O.P, Effect of sub cooling of condensate & superheating of refrigerant vapour on C.O.P of the cycle, Actual vapour compression refrigeration cycle,

Multistage System:

Multistage vapour compression system requirement, Different configuration of multi pressure system, Removal of flash gas, Intercooling, Multi evaporator system, Cascade system.

Unit-3

8 Hours

Vapour Absorption system;

Working Principal of vapour absorption refrigeration system, Comparison between absorption & compression systems, Elementary idea of refrigerant absorbent mixtures, Temperature – concentration diagram & Enthalpy – concentration diagram , Adiabatic mixing of two streams, Ammonia – Water vapour absorption system, Lithium- Bromide water vapour absorption system, Comparison, Three fluid system. **Refrigerants:**

Classification of refrigerants, Nomenclature, Desirable properties of refrigerants, Common refrigerants, Secondary refrigerants, and Environment friendly refrigerants, Anti-freeze solution, Phase changing materials, Ozone layer depletion and global warming considerations of refrigerants, Selection of refrigerants, Future Refrigerants like Hydrofluoro-Olefines

Unit-4

8 Hours

Air Conditioning:

Introduction to air conditioning, Psychrometric properties and their definitions, Psychrometric chart, Different Psychrometric processes, Air Washers, Cooling towers & humidifying efficiency, Thermal analysis of human body, Effective temperature and comfort chart, Cooling and heating load calculations, Selection of inside & outside design conditions, Heat transfer through walls & roofs, Infiltration & ventilation, Internal heat gain, Sensible heat factor (SHF), By pass factor, Grand Sensible heat factor (GSHF), Apparatus dew point (ADP).

Window air Conditioner, Simple air conditioning system, Air conditioning system with ventilation.

Unit-5

8 Hours

Refrigeration System Equipment:

Compressors, Condensers, Expansion Devices and Evaporators, Elementary knowledge of transmission and distribution of air through ducts and fans,

Application:

Food preservation, Transport refrigeration, Cold storage, Refrigerates Freezers, Ice plant, Water coolers, Comfort and Industrial air conditioning Refrigeration.

Other systems:

Cryogenic liquefaction and refrigeration systems, Brief introduction of Thermo-electric refrigeration system, Steam jet refrigeration system, Vortex tube refrigeration system, Magnetic refrigeration system.

Reference Books:

1. Refrigeration and Air conditioning by C.P Arora, McGraw-Hill
2. Refrigeration and Air conditioning, by Manohar Prasad, New Age International (P) Ltd. Pub.
3. Refrigeration and Air conditioning by R.C. Arora, PHI
4. Principles of Refrigeration by Roy J. Dossat. Pearson Education
5. Refrigeration and Air conditioning by Stoecker& Jones. McGraw-Hill
6. Refrigeration and Air conditioning by Arora&Domkundwar. DhanpatRai

7. Thermal Environment Engineering. By Kuhen, Ramsey & Theked

Subject Code: KME 602		Machine Design	L T P : 3 1 0	Credits: 4
Course Outcomes: The student will be able to				Blooms Taxonomy
CO 1	Recall the basic concepts of Solid Mechanics to understand the subject.			K2
CO 2	Classify various machine elements based on their functions and applications.			K2
CO 3	Apply the principles of solid mechanics to machine elements subjected to static and fluctuating loads.			K3
CO 4	Analyze forces, bending moments, twisting moments and failure causes in various machine elements to be designed.			K4
CO 5	Design the machine elements to meet the required specification.			K5

Unit I

8 Hours

Introduction

Definition, Design requirements of machine elements, Design procedure, Standards in design, Standards designation of carbon & alloy steels, Selection of preferred sizes, Selection of materials for static and fatigue loads, Design against Static Load

Design against Fluctuating Loads

Cyclic stresses, Fatigue and endurance limit, Stress concentration factor, Stress concentration factor for various machine parts, Design for finite & infinite life, Soderberg, Goodman, Gerber criteria

Unit II

8 Hours

Riveted Joints

Riveting methods, materials, Types of rivet heads, Types of riveted joints, Caulking and Fullering, Failure of riveted joint, Efficiency of riveted joint, Design of boiler joints, Eccentric loaded riveted joint

Welded Joints

Stress relieving of welded joints, Butt Joints, Fillet Joints, Strength of Butt Welds, Strength of parallel fillet welds, Strength of transverse fillet welds

Shafts

Cause of failure in shafts, Materials for shaft, Stresses in shafts, Design of shafts subjected to twisting moment, bending moment and combined twisting and bending moments, Shafts subjected to fatigue loads, Design for rigidity, Keys, Types of keys, Selection of square and flat keys, Strength of sunk key

Unit III

8 Hours

Spur Gears

Tooth forms, System of gear teeth, contact ratio, Standard proportions of gear systems, Interference in involute gears, Backlash, Selection of gear materials, Gear manufacturing methods, Design considerations, Beam strength of gear tooth, Dynamic tooth load, Wear strength of gear tooth, Failure of gear tooth, Design of spur gears, AGMA and Indian standards.

Helical Gears

Terminology, Proportions for helical gears, Force components on a tooth of helical gear, Virtual number of teeth, Beam strength and wear strength of helical gears, Dynamic load on helical gears, Design of helical gears.

Introduction, Classification and Applications of Bevel & Worm Gears

Unit IV

8 Hours

Sliding Contact Bearing

Types, Selection of bearing, Plain journal bearing, Hydrodynamic lubrication, Properties and materials, Lubricants and lubrication, Hydrodynamic journal bearing, Heat generation, Design of journal bearing.

Rolling Contact Bearing

Advantages and disadvantages, Types of ball bearing, Thrust ball bearing, Types of roller bearing, Selection of radial ball bearing, Bearing life, Selection of roller bearings, Dynamic equivalent load for roller contact bearing under constant and variable loading, Reliability of Bearing.

Unit V

8 Hours

IC Engine Parts

Selection of type of IC engine, General design considerations, Design of Cylinder and cylinder head; Design of piston, piston ring and gudgeon pin;

Friction Clutches

Clutches, Difference between coupling and clutch, Single plate friction clutch, Torque transmitting capacity, Multi-Disk Clutches, Friction Material

Note: Design data book is allowed in the examination

Text Books:

1. Design of Machine Elements-V.B. Bhandari, McGraw Hill Co.

2. Design of Machine Elements, Sharma and Purohit, PHI.

Reference Books:

1. Mechanical Engineering Design, 9e – Joseph E. Shigely, McGraw Hill Education.
2. Machine Design-Maleev and Hartman, CBS Publishers.
3. Design of Machine Design-M.F. Spott, Pearson Education.
4. Elements of Machine Component Design, Juvinal&Marshek, John Wiley & Sons.
5. Machine design, Robert L. Norton, Pearson Education
6. Theory & Problem of Machine Design (Schaum’s Outline Series) Hall, Holowenko, Laughlin, Tata McGraw Hill Co.
7. Machine Design-Sharma and Agrawal, S.K. Kataria& Sons.
8. Machine Design, U C Jindal, Pearson Education.

Subject Code: KME 603	Theory of Machines	L T P : 3 1 0	Credits: 4
Course Outcomes: The students will be able to			Blooms Taxonomy
CO1	Understand the principles of kinematics and dynamics of machines.		K2
CO2	Calculate the velocity and acceleration for 4-bar and slider crank mechanism		K3
CO3	Develop cam profile for followers executing various types of motions		K3
CO4	Apply the concept of gear, gear train and flywheel for power transmission		K3
CO5	Apply dynamic force analysis for slider crank mechanism and balance rotating & reciprocating masses in machines.		K3
CO6	Apply the concepts of gyroscope, governors in fluctuation of load and brake & dynamometer in power transmission		K3

Unit I

(09 Hours)

Introduction, mechanisms and machines, kinematics and kinetics, types of links, kinematic pairs and their classification, types of constraint, degrees of freedom of planar mechanism, Grubler’s equation, mechanisms, inversion of four bar chain, slider crank chain and double slider crank chain.

Velocity analysis: Introduction, velocity of point in mechanism, relative velocity method, velocities in four bar mechanism, instantaneous center.

Acceleration analysis: Introduction, acceleration of a point on a link, acceleration diagram, Coriolis’ component of acceleration, crank and slotted lever mechanism,.

Unit II

(10 Hours)

Cams: Introduction, classification of cams and followers, cam profiles for knife edge, roller and flat faced followers for uniform velocity, uniform acceleration

Gears and gear trains: Introduction, classification of gears, law of gearing, tooth forms and their comparisons, systems of gear teeth, length of path of contact, contact ratio, minimum number of teeth on gear and pinion to avoid interference, simple, compound, reverted and planetary gear trains, sun and planet gear train.

Unit III (08 Hours)

Force analysis: Static force analysis of mechanisms, D'Alembert's Principle, dynamics of rigid link in plane motion, dynamic force analysis of planar mechanisms, piston force and crank effort. Turning moment on crankshaft due to force on piston, Turning moment diagrams for single cylinder double acting steam engine, four stroke IC engine and multi-cylinder engines, Fluctuation of speed, Flywheel.

Unit IV (09 Hours)

Balancing: Introduction, static balance, dynamic balance, balancing of rotating masses, two plane balancing, graphical and analytical methods, balancing of reciprocating masses, balancing of single cylinder engine.

Governors: Introduction, types of governors, characteristics of centrifugal governors, gravity controlled and spring controlled centrifugal governors, hunting of centrifugal governors, inertia governors. Effort and Power of governor

Unit V (09 Hours)

Brakes and dynamometers: Introduction, Law of friction and types of lubrication, types of brakes, effect of braking on rear and front wheels of a four wheeler, dynamometers, belt transmission dynamometer, torsion dynamometer, hydraulic dynamometer

Gyroscope: Space motion of rigid bodies, angular momentum, gyroscopic couples, gyroscopic stabilization, ship stabilization, stability of four wheel and two wheel vehicles moving on curved paths.

Text / Reference Books

1. Kinematics and dynamics of machinery: Wilson and Sadler, Third edition, Pearson.
2. Theory of Mechanisms and Machines: Amitabh Ghosh and Ashok Kumar Mallik, Third Edition Affiliated East-West Press.
3. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Oxford University Press
4. Kinematics and dynamics of machinery: R L Norton, McGraw Hill
5. Theory of Machines: S.S. Rattan, McGraw Hill
6. Theory of Machines: Thomas Bevan, CBS Publishers.

Suggested Software

MechAnalyzer

Subject Code: KME 651	Refrigeration & Air Conditioning Lab	L T P : 0 0 2	Credits: 1
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The students will be able to:		Blooms Taxonomy
CO1	Determine the performance of different refrigeration and air-conditioning systems.	K3
CO2	Apply the concept of psychrometry on different air cooling systems.	K3
CO3	Interpret the use of different components, control systems and tools used in RAC systems	K3
CO4	Demonstrate the working of practical applications of RAC systems.	K2

Minimum eight experiments out of the following:

1. Experiment on refrigeration test rig and calculation of various performance parameters.
2. Experiment on air-conditioning test rig & calculation of various performance parameters.
3. Study of Psychrometer and determination of humidity of air using Sling Psychrometer.
4. To study and perform experiment on vapour absorption apparatus.

5. To study the air washer and perform different psychometric processes on air washer.
6. Study of desert coolers and determine the change in temperature and humidity of ambient air.
7. Handling, use and familiarization with refrigeration tools and accessories such as: Tube cutter; Tube bender [spring type]; Flaring tool; Swaging tool; Pinch off etc.
8. Study of window air conditioner.
9. Study of Hermetically sealed compressor.
10. To study basic components and control devices of refrigeration and air-conditioning system.
11. Experiment on Ice-plant and calculation of various performance parameters.
12. Visit of a central air conditioning plant and its detailed study.
13. Visit of cold-storage and its detailed study.

Subject Code: KME 652	Machine Design Lab	L T P : 0 0 2	Credits: 1
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Course Outcomes: The student will be able to		Blooms Taxonomy
CO-1	Apply the principles of solid mechanics to design various machine Elements subjected to static and fluctuating loads.	K3
CO-2	Write computer programs and validate it for the design of different machine elements	K4
CO-3	Evaluate designed machine elements to check their safety.	K5

A Design of Machine Elements

1. Design a knuckle joint subjected to given tensile load.
2. Design a riveted joint subjected to given eccentric load.
3. Design of shaft subjected to combined constant twisting and bending loads
4. Design a transverse fillet welded joint subjected to given tensile load.
5. Design & select suitable Rolling Contact Bearing for a shaft with given specifications
6. Design a cylinder head of an IC Engine with prescribed parameters.
7. Design of Piston & its parts of an IC Engine

B. Computer Programs for conventional design

Computer and Language

Students are required to learn the basics of computer language such as C/C++/MATLAB so that they should be able to write the computer program.

1. Design a pair of Spur Gear with given specifications to determine its various dimensions using Computer Program in C/C++.
2. Design a pair of Helical Gear with given specifications to determine its various dimensions using Computer Program in C/C++.
3. Design of Sliding Contact Bearing with given specifications & determine its various parameters using Computer Program in C/C++.

Subject Code: KME 653	Theory of Machines Lab	L T P : 0 0 2	Credits: 1
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The students will be able to:		Blooms Taxonomy
CO1	Demonstrate various mechanisms, their inversions and brake and clutches in automobiles	K2
CO2	Apply cam-follower mechanism to get desired motion of follower.	K3
CO3	Apply the concepts of gears and gear train to get desired velocity ratio for power transmission.	K3
CO4	Apply the concept of governors to control the fuel supply in engine.	K3
CO5	Determine the balancing load in static and dynamic balancing problem	K3

List of Experiments

(Minimum eight experiments out of the following)

NOTE: Student has to write computer program in C / C++ / Python and to run to compute the output values for at least ONE experiments.

1. To study various types of kinematics links, pairs, chains & Mechanisms

2. To study Whitworth Quick Return Motion Mechanisms, Reciprocating Engine Mechanism, and Oscillating Engine Mechanism
3. To study of inversions of four bar linkage
4. To study of inversions of single/double slider crank mechanisms
5. To study various types of gear (Helical, cross helical, worm, bevel gear) and gear profile (involute and cycloidal) and condition for interference Helical, cross helical, worm, bevel gear
6. To compute the output velocity in various gear trains
7. To study gyroscopic effects through models
8. To determine gyroscopic couple on Motorized Gyroscope
9. To perform experiment on dead weight type governor to prepare performance characteristic Curves, and to find stability & sensitivity
10. To perform experiment on spring controlled governor to prepare performance characteristic Curves, and to find stability & sensitivity
11. To determine whirling speed of shaft theoretically and experimentally
12. To perform the experiment for static / dynamic balancing
13. To perform experiment on brake
14. To perform experiment on clutch
15. To perform the experiment for static / dynamic balancing.
16. To perform experiment on longitudinal vibration
17. To perform experiment on transverse vibration

Manufacturing and Automation

Course Outcome: Student will be able to		Bloom Taxonomy	
CO 1	Understand the concept of destructive and Non-destructive testing methods.	K2	
CO 2	Explain the working principle and application of die penetrant test and magnetic particle inspection.	K2	
CO3	Understand the working principle of eddy current inspection.	K2	
CO 4	Apply radiographic techniques for testing.	K3	
CO 5	Apply the principle of Ultrasonic testing and applications in medical and engineering areas.	K3	
Subject Code: KME 061	Nondestructive Testing	L T P : 3 0 0	Credits: 3

C**Unit-I:**

Introduction to NDT, DT, advantages & limitations of NDT, classification of NDT methods, Comparison with DT, Terminology, Flaws and Defects. Scope of NDT. Codes, Standards and Certifications in NDT.

Visual Inspection– Equipment used for visual inspection, Borescopes, Application of visual inspection tests in detecting surface defects and their interpretation, advantages & limitations of visual inspection, Visual Inspection in Welding.

Unit-II:

Liquid Penetrant Testing – Principle, Scope, Testing equipment, Advantages, Limitations, types of penetrants and developers, standard testing procedure, Dye test, Illustrative examples and interpretation of defects.

Magnetic Particle Inspection – Principle, Scope, Testing equipment, Advantages, Limitations, Application of MPI & standard testing procedure, DC & AC magnetization, Skin Effect, different methods to generate magnetic fields, Illustrative examples and interpretation of defects.

Unit-III:

Radiographic Testing – Introduction to electromagnetic waves and radioactivity, various decays, Attenuation of electromagnetic radiations, Photoelectric effect, coherent scattering and Incoherent scattering, Beam geometry.

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X-ray Radiography – Principle, equipment & methodology, applications, source, types of radiations and limitations; γ -ray Radiography – Principle, equipment, γ -ray source & technique; Radiography Image Quality Indicators, Film Processing, advantages of γ -ray radiography over X-ray radiography. Precautions against radiation hazards.

Unit-IV:

Ultrasonic Testing – Introduction, Principle, Piezoelectricity and Piezoelectric Transducers, Wave propagation, Ultrasonic probes, selection of angle probes, Acoustic Impedance, Reflection and transmission coefficient, Snell's law, standard testing procedure & calibration, advantages & limitations. Data representation - A-scan, B-scan, C-scan. Applications in inspection of welded joints, castings, forgings and dimensional measurements. Introduction to TOFD & Phased Array Ultrasonic Testing.

Unit-V:

Special NDT Techniques:

Eddy Current Inspection– Introduction, Principle, Methods, scope, Equipment, types of probes, Sensitivity, standard testing procedure, advanced ECT methods, advantages and limitations.

Acoustic Emission Technique– Introduction, Types of AE signal, Principle, Advantages & Limitations, Interpretation of Results, Applications.

Holography, Thermography– Introduction, Principle, advantages, limitations and applications.

Books and References:

1. Non-Destructive Testing and Evaluation of Materials, by- Prasad, McGraw Hill Education.
2. Practical Non-destructive Testing, by- Baldev Raj, T. Jayakumar, M. Thavasimuthu, Woodhead Publishing.
3. Non-Destructive Testing Techniques, by- Ravi Prakash, New Age International.
4. Non destructive Testing Handbook, by Robert C. McMaster, American Society for Nondestructive.
5. Introduction to Non destructive Testing: A Training Guide, by- Paul E. Mix, wiley.
6. Electrical and Magnetic Methods of Non-destructive Testing, by- J. Blitz, springer.
7. Practical non destructive testing by Raj, Baldev.
8. Basics of Non-Destructive Testing, by Lari& Kumar, KATSON Books.
9. ASME Sec. V, boiler and pressure vessel code

Automation and Industry 4.0

Subject Code: KME 062	Artificial Intelligence	L T P : 3 0 0	Credits: 3
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MECHANICAL ENGINEERING

Course Outcomes: Students are able to		Bloom's Taxonomy
CO 1	Understand concepts of Artificial Intelligence	K2
CO 2	Solve problem by Search-I & Search-II	K3
CO 3	Understand Knowledge representation	K2
CO 4	Apply concepts of Learning methods	K3
CO 5	Analyse Decision Networks	K4
CO 6	Build planning graphs	K5

C

Unit 1: (9Hours)

Introduction of Artificial Intelligence, Intelligent Agents, and Behaviors of Artificial Agents, Structure of Intelligent Agents. Problem solving and state space search, Uninformed Search, Heuristic search, BestFirst Search, Heuristic Functions, Constraints satisfaction problem, Iterative Improvement Algorithms.

(Recommended lab practice sessions: Games as Search Problems, Alpha-Beta Pruning, State-of-the-Art Game Programs.)

Unit 2: (8Hours)

Introduction to Knowledge Representation, Propositional Logic, 1st order logic-I, 1st order logic-II, Inference in First-Order Logic, Using First-Order Logic, Building a Knowledge Base, Logical Reasoning Systems; Indexing, Retrieval, and Unification, Inference in FOL-II, Answer Extraction.

Unit 3: (9Hours)

Procedural control of reasoning, reasoning under uncertainty, Bayesian Networks, Decision Networks, Uncertain knowledge and reasoning, The Axioms of Probability, Bayes' Rule and Its Use, Probabilistic Reasoning Systems, Making Simple Decisions, Making Complex Decisions, Introduction to Planning, Practical Planning and Acting, Inductive Learning, Learning from Observations.

Unit 4: (7Hours)

Neural Networks: Learning in Neural Networks, How the Brain Works, Perceptron, Multilayer FeedForward Networks, Applications of Neural Networks, Introduction to Learning, Kinds of Learning,

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Supervised and Unsupervised Learning, Clustering, Reinforcement Learning.

Learning a Function, Aspects of Function Learning, and Types of function learning aspects: Memory, Averaging and Generalization, Example problems based on Function Learning. Learning methods, Nearest Neighbor, Decision Trees, and Neural Networks.

Unit 5:

(7Hours)

Intelligent Agents, Types of Communicating Agents, A Communicating Agent, Practical Natural Language Processing: Practical Applications, Efficient Parsing, Scaling Perception: Image-Processing Operations for Early Vision, Using Vision for Manipulation and Navigation, Speech Recognition. Robotics: Tasks: What Are Robots Good For? Parts: What Are Robots Made Of? Architectures, Configuration Spaces: A Framework for Analysis, Navigation and Motion Planning

Text Book:

1. Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, Pearson Education

Reference Books:

2. Elaine Rich and Kevin Knight, “Artificial Intelligence”, McGraw-Hill
3. E Charniak and D McDermott, “Introduction to Artificial Intelligence”, Pearson Education
4. Dan W. Patterson, “Artificial Intelligence and Expert Systems”, Prentice Hall of India,

Design and Analysis

Subject Code: KME 063	Tribology	L T P : 3 0 0	Credits: 3
Course Outcome: Student will be able to			Bloom Taxonomy
CO 1	Identify and explain various friction and wear mechanisms.		K2
CO 2	Select proper lubricants for different applications.		K3
CO 3	Select suitable lubrication methods in different bearings.		K3
CO 4	Study the surfaces coating techniques for reduction of wear.		K3
CO 5	Analyze the impact of friction in various kinematic pairs.		K4

UNIT –I Lubrication and Lubricants

Introduction to tribology, tribology in industry, basics modes of lubrication, oil viscosity, temperature and pressure dependence of viscosity, Viscosity index, viscosity measurement, properties of lubricants, temperature characteristics of lubricants, lubricant impurities and contaminants, mineral oils based lubricants, synthetic oils based lubricants, emulsions and aqueous lubricants, greases, and lubricant additives.

UNIT –II Friction and Wear

Friction-causes of friction, theories of dry friction; adhesion theory, abrasive theory, junction growth theory, laws of rolling friction, friction measurement, friction instabilities.

Wear- classification; abrasive wear, erosive wear, cavitation wear, adhesive wear, corrosive wear, oxidative wear, fatigue wear, factors affecting wear, measurement of wear, theories of wear, approaches to friction control and wear prevention.

UNIT –III Lubrication of Bearings

Theory of hydrodynamic lubrication, mechanism of pressure development in oil film, jet lubrication, mist lubrication, lubrication utilizing under race passage, concept of journal bearing, minimum oil film thickness, porous bearings, flat plate thrust bearing, tilting pad bearings, hydrostatic lubrication, squeeze film lubrication, elasto-hydrodynamic lubrication, rolling element bearings, gas lubricated bearings, and hybrid bearings.

UNIT –IV Solid Lubrication and Surface Treatment

Lubrication by solids, friction and wear characteristics of lamellar solids, reduction of friction by soft metallic films, deposition methods of solid lubricants, techniques for producing wear resistant coatings, characteristics of wear resistant coatings.

UNIT –V Friction, Lubrication and Wear in Kinematic pairs

The concept of friction angle, friction stability, friction in slideways, friction in screws with square threads, friction in screws with triangular threads, mechanism and operation of plate clutch, cone clutch, rim clutch, centrifugal clutch, and belt drives, tribo design aspects of labyrinth seals, analysis of line contact lubrication, analysis of point contact lubrication, cam follower system, traction in the contact

Semester – VI: Departmental Elective – III: Specialization –

zone, and hysteresis losses.

Books and References:

1. Fundamentals of Engineering Tribology with Applications by Harish Hirani, Cambridge English (2017)
2. Applied Tribology (Bearing Design and Lubrication), by Michael M Khonsari, John Wiley & Sons (2001).
3. Principles of Tribology, by J Halling, The Macmillan Press Ltd, London, (1975).
4. Friction, Wear, Lubrication: A textbook in Tribology, by Ludema K C, CRC Press, (2010).
5. Fundamentals of Machine Elements, B.J. Hamrock, B.O. Jacobson & S.R. Schmid, McGraw-Hill Inc., (1998).
6. Fundamentals of Mechanical Component Design, by K.S. Edwards & R.B. McKee, McGraw-Hill Inc., (1991).
7. Mechanical Engineering Design by J.E. Shigley and C R Mischke, Tata McGraw-Hill Publishing Company Limited, (2003).
8. Tribophysics, by N.P. Suh Prentice-Hall, (1986).
9. Friction, Wear, Lubrication: A Textbook in Tribology, by Kenneth C Ludema, LayoAjayi, CRC Press (2019).

MECHANICAL ENGINEERING

Thermal Engineering

Subject Code: KME 064	Gas Dynamics and Jet Propulsion	L T P : 3 0 0	Credits: 3
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Course Outcomes: The students will be able to		Blooms Taxonomy
CO1	Understand the concept of compressible fluid flow and flow through variable area ducts.	K2
CO2	Understand the basic principle and types of jet and rocket propulsion.	K2
CO3	Apply the basic laws for the investigation of flow through ducts.	K3
CO4	Apply the basic laws for the thermodynamics analysis of jet and rocket propulsion.	K3
CO5	Analyze the compressible flow through variable area ducts.	K4

UNIT -I:

Compressible flow, definition, Mach waves and Mach cone, stagnation states, Mass, momentum and energy equations of one-dimensional flow.

UNIT-II:

Isentropic flow through variable area ducts, nozzles and diffusers, subsonic and supersonic flow variable area ducts, choked flow, Area-Mach number relations for isentropic flow.

UNIT -III:

Non-isentropic flow in constant area ducts, Rayleigh and Fano flows, Normal shock relations, oblique shock relations, isentropic and shock tables.

UNIT -IV:

Theory of jet propulsion, thrust equation, thrust power and propulsive efficiency, Operating principle and cycle analysis of ramjet, turbojet, turbofan and turboprop engines.

UNIT -V:

Types of rocket engines, propellants & feeding systems, ignition and combustion, theory of rocket propulsion, performance study, staging, terminal and characteristic velocity, space flights.

Books and References:

1. Ahmed F. El-Sayed, Aircraft Propulsion and Gas Turbine Engines, CRC Press, 2008.
2. H.S. Mukunda, "Understanding Aerospace Chemical Propulsion", Interline Publishing, 2004.
3. Hill P. and Peterson C., Mechanics & Thermodynamics of Propulsion, Addison Wesley, 1992.
4. Zucrow N. J., Aircraft and Missile Propulsion, Vol. I & II, John Wiley, 1975.

Semester – VI: Departmental Elective – III: Specialization –

5. Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 1986.

Semester – VI: Departmental Elective – III: Specialization – Automobile Engineering

Subject Code: KAU 061	Automotive Electrical and Electronics	L T P : 3 0 0	Credits: 3
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The students will be able to		Blooms Taxonomy
CO-1	Understand the basic concepts of electrical systems used in automobile.	K2
CO-2	Understand the constructional features of charge storage devices and methods to test these devices for their healthy operation.	K2
CO-3	Understand the principles and characteristics of charging and starting system of automobile and study the various faults occurring in system.	K2
CO-4	Understand the ignition and auxiliary system- types & constructional features used in automobile.	K2
CO-5	Describe the principles and architecture of electronics systems and its components present in an automobile related to data transfer, instrumentation, control, and security systems.	K2
CO-6	Understand latest trends developed in electrical and electronic systems of automobile and their advantages over conventional technologies.	K2

Unit 1

[L 8 Hours]

Introduction to electrical fundamentals – Ohm’s Law, Kirchoff’s Law, Capacitance and Inductance, Simple Electric Circuits, Automotive Wiring Harnesses, Insulated and Earth Return System, Positive and Negative Earth Systems, Connectors and its types

Charge storing devices- Principle and construction of Lead Acid Battery, Nickel – Cadmium Battery, Nickel Metal, Hybrid Battery, Sodium Sulphur Battery and Aluminum Air Battery-Choice of Batteries for automotive applications, Characteristics of Battery, Battery Rating, Capacity and Efficiency, Various Tests on Battery, Battery– Charging Techniques. Maintenance of batteries.

Unit 2

[L 8 Hours]

Starter Systems- Requirements of Starter Motor, Starter Motor types, construction and characteristics, Starter drive mechanisms, Starter Switches and Solenoids.

Charging system components, Generators and Alternators, types, construction and Characteristics,

Charging System- Voltage and Current Regulation, Cut –out relays and regulators, Charging circuits for D.C. Generator, A.C. Single Phase and Three – Phase Alternator

Unit 3

[L 8 Hours]

Automotive Ignition Systems: Spark Plugs, Constructional details and Types, Battery Coil and Magneto– Ignition System Circuit details and Components, Centrifugal and Vacuum Advance Mechanisms, Non– Contact– type Ignition Triggering devices, Capacitive Discharge Ignition, Distributor–less Ignition Systems

Auxiliary Systems: Head Lamp and Indicator Lamp construction and working details, Focusing of head lamps, Anti– Dazzling and Dipper Details, Automotive Wiring Circuits. Indicators and meters, speedometers, electric horn, windshield wiper, electric horn and relay devices.

Semester – VII: Departmental Elective – V: Specialization –

Unit 4

[L 8 Hours]

Automotive Electronics: Automotive networking, Bus system, Advantages of bus systems, requirements of buses, Buses in motor vehicle: CAN, FlexRay, LIN, Ethernet, IP, PSIS, MOST bus and optical fibers/wave guides, Architectures of electronic system.

Control Units: ECM, ABS control unit, Steering Control Unit, SRS control unit, Automatic Air Conditioning Control Unit.

Unit 5

[L 8 Hours]

Automotive Sensors and Actuators: Basic principle, Main requirements, Micromechanics, Position sensors, Speed and RPM sensors, Acceleration and vibration sensors, Pressure sensors, Flow meters, Gas sensors, concentration sensors, temperature sensors, Force sensors, Optoelectronics sensors, Sensors for driver assistance systems: Ultrasonic technology, Radar technology, LIDAR sensors Purge Control, Idling Setting Control, Immobilizer System, Stepper motors.

Books:

1. Automotive Electricals by PL Kohli, McGraw Hill Publications.
2. Robert Bosch “Automotive Hand Book”, SAE (8th Edition), 2011.

References:

1. Tom Denton, “Automobile Electrical and Electronic Systems” 4th edition- Routledge - 2012.
2. Barry Hollembeak, “Automotive Electricity and Electronics”, Delmar Cengage Learning; 5th edition, 2011