

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



COURSE STRUCTURE/EVALUATION SCHEME

FOR

B.TECH. 4th YEAR

MECHANICAL ENGINEERING

[Effective from Session: 2025-26]

B. Tech.
Mechanical Engineering
Evaluation Scheme
[Effective from Session: 2025-26]

SEMESTER- VII														
S. No.	Code	Subject	Learning Mode	LTP			Evaluation Scheme						Total	Credit
				L	T	P	CT	TA	Total	PS	TE	PE		
1	BME701	Measurement & Metrology	Offline	3	-	-	20	10	30	-	70	-	100	3
2	BME070	Departmental Elective-IV	Offline	3	-	-	20	10	30	-	70	-	100	3
4	BOEM**	Open Elective-II	Offline/MOOCs	3	0	0	20	10	30	-	70	-	100	3
5	BME751	Measurement & Metrology Lab	Offline	0	0	2	-	-	-	50	-	50	100	1
6	BME752	Mini Project or Internship Assessment*		0	0	4	-	-	-	100	-	-	100	2
7	BME753	Project-1		0	0	10	-	-	-	150	-	-	150	5
8	BME754	Startup and Entrepreneurial Activity Assessment#		0	0	4	-	-	-	100	-	-	100	2
		Total		9	0	20							750	19
		*The Mini Project or internship (5-6 weeks) conducted during summer break after VI semester and will be assessed during VII semester. # The Startup and Entrepreneurial Activity Assessment will be done in 7 th semester under which a student will have to undergo a startup/entrepreneurship activity of at least 60 hours till 6 th semester.												

SEMESTER- VIII														
S. No	Code	Subject	Learning Mode	Periods			Evaluation Scheme				End Semester		Total	Credit
				L	T	P	CT	TA	Total	PS	TE	PE		
1	BOEM**	Open Elective-III	MOOCs	3	0	0	20	10	30	-	70	-	100	3
2	BOEM**	Open Elective-IV	MOOCs	3	0	0	20	10	30	-	70	-	100	3
3	BME851	Project-II		0	0	18				100		350	450	10
		Total		6	0	18	24						650	16

The Internal Assessment of MOOCs will be done by the respective institute and the external Assessment (End Semester Examination) will be done by the University)

Departmental Electives

		Specialization-1	Specialization-2	Specialization-3	Specialization-4
Semester	Specialization	Manufacturing & Automation	Thermal Engineering	Design Engineering	Automobile Engineering
VII	Departmental Elective-IV	BME071	BME072	BME073	BAU071
		Additive Manufacturing	Power Plant Engineering	Computer Graphics and Product Modeling	Hybrid Vehicle Propulsion

Subject Code: BME701	Measurement & Metrology	L T P : 3 0 0	Credits: 3
-----------------------------	------------------------------------	----------------------	-------------------

Course Outcome: Student will be able to		Bloom Taxonomy
CO 1	Explain the basics knowledge of measurements. and also develop competence in sensors, transducers	K2
CO 2	Understand and able to use various devices for measuring, strain, Pressure and time related equipment.	K2
CO 3	Understand and able to use various devices for measuring, Flow, Temperature, Force & Torque.	K2
CO 4	Explain the basics knowledge of metrology & Inspection.	K2
CO 5	Understand the fundamentals of various methods for the measurements of surface roughness parameters and working of optical measuring instruments.	K2

UNIT I

Mechanical Measurements: Introduction to measurement and measuring instruments. General concept– Generalized measurement system and its elements-Unit sand standards- measuring instruments: sensitivity, stability, range, accuracy and precision-static and dynamic response- repeatability-systematic, Source of error, statistical analysis of error and random errors- correction, calibration. Dimensional and geometric tolerance

Sensors and Transducers: Types of sensors, types of transducers and their characteristics.

UNIT II

Time Related Measurements: Stroboscope, frequency measurement by direct comparison. Measurement of displacement

Measurement of Pressure: Gravitational, directing acting, elastic and indirect type pressure transducers. Measurement of very low pressures (high vacuum).

Strain Measurement: Types of strain gauges and their working, strain gauge circuits, temperature compensation. Strain rosettes, calibration.

UNIT III

Flow Measurement: Hot Wire Anemometry, Laser Doppler Velocimetry, Rotameter.

Temperature Measurement: Thermometers, bimetallic thermocouples, thermistors and pyrometers.

Measurements of Force & Torque: Different types of load cells, elastic transducers, pneumatic & hydraulic systems. Seismic instruments.

UNIT IV

Metrology and Inspection: Standards of linear measurement, line and end standards. Interchange ability and standardization. Linear and angular measurements devices and systems

Comparators: Sigma, Johansson's Microkrator, Limit gauges classification, Taylor's Principle of Gauge Design.

UNIT-V

Limits, Fits &Tolerance and Surface roughness: Introduction to Limits, Fits, Tolerances and IS standards, Limit-gauges, and surface-roughness. Measurement of geometric forms like straightness, flatness, roundness. Tool makers microscope, profile projector, autocollimator.

Interferometry: principle and use of interferometry, optical flat. Measurement of screw threads and gears. Surface texture: quantitative evaluation of surface roughness and its measurement.

Books and References:

1. Experimental Methods for Engineers by Holman, MCGRAW HILL INDIA
2. Mechanical Measurements by Beckwith, Pearson
3. Principles of Measurement Systems by Bentley, Pearson
4. Metrology of Measurements by Bewoor and Kulkarni, MCGRAW HILL INDIA
5. Measurement Systems, Application Design by Doeblein, MCGRAW HILL INDIA
6. Hume KJ, "Engineering Metrology", MacDonald and Co
7. Jain, RK, "Engineering Metrology" Khanna Publishers
8. Jain, R.K., "Mechanical Measurement" Khanna Publishers
9. Gupta SC, Engineering Metrology, Dhanpat Rai Publications

Departmental Elective – IV

Subject Code: BME071	Additive manufacturing	L T P : 3 0 0	Credits: 3
-----------------------------	-------------------------------	----------------------	-------------------

Course Outcome: Student will be able to			Bloom Taxonomy
CO 1	Understanding the basics of additive manufacturing/rapid prototyping and its advantages and disadvantages		K2
CO 2	Understanding the role of additive manufacturing in the design process and the implications for design.		K2
CO 3	Understanding the processes used in additive manufacturing for a range of materials and applications		K2
CO 4	Understand the various software tools, processes and techniques that enable advanced/additive manufacturing and personal fabrication.		K2
CO 5	Apply knowledge of additive manufacturing for various real-life applications		K3

UNIT I

Introduction

History and Advantages of Additive Manufacturing, Distinction Between Additive Manufacturing and CNC Machining, Types of Additive Manufacturing Technologies, Nomenclature of AM Machines, Direct and Indirect Processes; Prototyping, Manufacturing and Tooling.

Layer Manufacturing Processes: Polymerization, Sintering and Melting, Extrusion, Powder Binder Bonding, Layer Laminate Manufacturing, Other Processes; Aerosol printing and Bio plotter.

UNIT II

Development of Additive Manufacturing Technology

Computer Aided Design Technology, Other Associated Technology, Metal and Hybrid Systems.

Generalized Additive Manufacturing Process Chain: The Eight Steps in Additive Manufacturing, Variation from one AM Machine to Another, Metal System, Maintenance of Equipment, Material Handling Issue, Design of AM.

UNIT III

Additive Manufacturing Processes

Vat Photo polymerization: Materials, Reaction Rates, Photo polymerization Process Modelling, Scan Patterns

Powder Bed Fusion Processes: Material, Powder Fusion Mechanism, Process Parameters and Modeling, powder Handling

Extrusion Based System: Basic principles, plotting and Path Control, Other Systems

Material Jetting: Materials, Material Processing Fundamentals, Material Jetting Machines

Directed Energy Deposition Processes: General DED Process Description, Material Delivery, DED systems, Process Parameters, Processing-Structure-Properties Relationships

UNIT IV: Design & Software Issues

Additive Manufacturing Design and Strategies: Potentials and Resulting Perspectives, AM based New Strategies, Material Design and Quality Aspects for Additive Manufacturing; Material for AM, Engineering Design Rules for AM.

Software Issue for Additive Manufacturing: Introduction, Preparation of CAD Models: The STL file, Problem with STL file, STL files Manipulation, Beyond the STL file, Additional Software to Assist AM

UNIT V

Material Design & Quality Aspects

Machines for Additive Manufacturing, Printers, Secondary Rapid Prototyping processes, Intellectual Property, Product Development, Commercialization, Trends and Future Directions in Additive Manufacturing, Business Opportunities

Applications

Aerospace, Automotive, Manufacturing, Architectural Engineering, Art, Jewellery, Toys, Medical, Biomedical, Dental, Bio-printing, Tissue & Organ Engineering and many others.

Books and References:

1. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, by- Ian Gibson, D Savid W. Rosen, Brent Stucker, Springer.
2. Understanding Additive Manufacturing, by- Andreas Gebhardt, Hanser.
3. Additive Manufacturing, by- Amit Bandyopadhyay, Susmita Bose, CRC Press.
4. Rapid Prototyping: Principles and Applications, by -Chee Kai Chua, Kah Fai Leong, Chu Sing Lim.

Departmental Elective – IV

Subject Code: BME072	Power Plant Engineering	L T P : 3 0 0	Credits: 3
-----------------------------	--------------------------------	----------------------	-------------------

Course Outcome: Student will be able to		Bloom Taxonomy
CO1	Understand the different sources of power generation and their impact on environment.	K2
CO2	Understand the elements of power generation using conventional and non-conventional energy sources.	K2
CO3	Understand the concepts of electrical systems used in power plants.	K2
CO4	Apply the basic concepts of thermodynamics to measure the performance of different power plants.	K3
CO5	Determine the performance of power plants based on load variations.	K3

UNIT I

Introduction to Power Plants

Introduction to the sources of energy: conventional and non-conventional; Principal types of power plants; Present status and future trends; Carbon credits.

Thermal Power Plant

General layout of modern thermal power plant, Review of Rankine and modified Rankine cycles, Power plant boilers including critical and super critical boilers. Fluidized bed boilers, boilers mountings and accessories. Feed water treatment and condenser and cooling towers and cooling ponds, Turbine auxiliary systems such as governing, feed heating, reheating, flange heating and gland leakage. Operation and maintenance of steam power plant, heat balance and efficiency, Site selection of a steam power plant.

UNIT II

Hydroelectric Power Plant

Hydro-electric plant, General arrangement of hydroelectric power plant, Plant layout, Penstock and water hammer, Specific speed and capacity calculations, Classification of hydro-plant, Low-, medium- and high-head plants, Pumped storage plant, Run-off river power plant, Surge tanks.

Gas turbine power plant:

Layout of gas turbine power plant, Elements of gas turbine power plants, Gas turbine fuels, cogeneration, auxiliary systems such as fuel, controls and lubrication, operation and maintenance, combined cycle power plants, Site selection of gas turbine power plant, Integrated Gas fire based Combined Cycle (IGCC) systems. Controlling of air fuel ratio (AFR) in power plant.

UNIT III

Nuclear Power Plants

Classification of nuclear reactors, Thermal fission reactors and power plant and their location, Pressurized water reactor, Boiling water reactor, CANDU heavy water reactor, Gas-cooled reactor, Fast breeder reactors, Organic substance cooled reactor, Reactor control, Radiation hazards, Radioactive waste disposal, Nuclear power generation in India.

Solar Power Plant

Solar energy collectors, Photovoltaic power system, Solar central receiver system, Solar thermal energy, types of solar thermal plant, typical layout and components, solar parabolic trough plants, solar tower power plants, and solar dish power plants. Working principle of concentrating solar thermal power plant and their applications.

UNIT IV

Non-Conventional Power Plants

Geothermal energy: Hydrothermal systems, Petro thermal systems, Hybrid geothermal fossil systems, Problems associated with geothermal conversion,

Wind energy: Components of a wind generator, Horizontal and vertical axis wind mills, Aerodynamic considerations of wind mill design, Coefficient of performance of wind mill rotor, Availability of wind energy in India, Wind power by country.

Tidal energy: The simple single pool tidal system, The modulated single pool tidal system, The two-pool tidal system, Ocean thermal energy conversion, Principle of working, Ocean temperature differences, The open or Claude cycle, The closed or Anderson OTEC cycle, Electricity generation from Fuel cells and city garbage.

UNIT V

Electrical system:

Introduction to generator and exciters, Earthing of power systems, Power and unit transformer, Circuit breakers, Protective equipment, Switch gear.

Power Plant Economics:

Types of loads, Effect of variable load on power plant design and operation, Methods to meet variable load, Prediction of future loads, Terminology used in power supply, Cost of electrical energy, Depreciation, Energy rates (tariffs) for electrical energy, Factors affecting economics of generation and distribution of power

Environmental Aspects of Power Station

Environmental aspects, Different pollutants due to thermal power plant and their effect on human health, Thermal pollution of water and its control, Effluents from power plants and impact on environment, Radiation from nuclear power plant effluents, Methods of pollution mitigation and control.

Books and References:

1. Power Plant Engineering, by F.T. Morse, Affiliated East-West Press Pvt. Ltd.
2. Power Plant Engineering by Hedge, Pearson India.
3. Power Plant Technology, by Wakil, McGraw Hill.
4. Power Plant Engineering by P.K. Nag, Tata McGraw Hill.
5. Steam & Gas Turbines & Power Plant Engineering by R.Yadav, Central Pub.House.
6. Power Plant Engineering by Gupta, PHI India.
7. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
8. Power Plant Engineering. Mahesh Verma, Metropolitan Book Company Pvt. Ltd.

Departmental Elective – IV

Subject Code: BME073	Computer Graphics and Product Modeling	L T P : 3 0 0	Credits: 3
-----------------------------	---	----------------------	-------------------

Course Outcome: Student will be able to		Bloom Taxonomy
CO 1	Understand the components of a computer graphics with object representation and to develop algorithm for graphics system components.	K2
CO 2	Understand the basic principles of 3- dimensional computer graphics and express the 3D model with illumination and shading effects.	K2
CO 3	Develop a 3D solid model using 3D Solid Modeling Software	K4
CO 4	Identify the customer needs in order to develop a business model for new product.	K3
CO 5	Develop strategy for designing and development of a new product	K4

UNIT-I

Introduction to computer graphics – historical evolution, issues and challenges, graphics pipeline, hardware and software basics; line and circle drawing algorithms, Object representation – boundary representation, splines- cubic, Bezier, B-spline and NURBS, space partitioning

Unit-II

Modeling transformations – matrix representation, homogeneous coordinate system, composition, 3D transformations; Illumination and shading – background, simple lighting model, shading models, intensity representation, color models, texture synthesis.

Unit-III

3D Graphics: Polygon Surfaces-Polygon mesh representations, Quadric and Super quadric surfaces and blobby objects, Solid modeling-Solid entities, Fundamentals of Solid modeling-Set theory, regularized set operations; Half spaces, Boundary representation, Constructive solid geometry, Sweep representation, Color models. Application Commands for 3D Solid Modeling Software like Solidworks /Autodesk Inventor/ PTC Creo / Catia (Any one) etc.

Unit-IV

Managing Product Development- Introduction; Business Models for New Products; Managing Product Development; Understanding Customer Needs- Identifying New Product Opportunities, Market Research for New Product Development. Introduction to Product Life Cycle Management and related software

Unit-V

Organizing Product Development-Product Architecture, Design for manufacturing and Prototyping; Organizing for Product Development; Developing Services and Product Service Systems; New Product Strategy- Building Markets and Creating Demand for New Products; Intellectual Property Issues in Product Development; New Product Business Plans – Strategy Consulting for New Products; Design Thinking for New Products- Designing Products for Emerging Markets; Design Thinking for New Products

Books and References

1. Samit Bhattacharya. (2015). Computer Graphics. Oxford University Press.
2. Hearn, D. & Baker, M. P. (2003). Computer Graphics with OpenGL, (3rd ed), Pearson.
3. Drew Boyd & Jacob Goldenberg (2013) Inside the Box: The Creative Method that Works for Everyone
4. Joseph V. Sinfield, Edward Calder, Bernard McConnell, and Steve Colson (2012) How to Identify New Business Models, MIT Sloan Management Review Vol. 53, No.2.
5. Chun-Che Huang (2000) Overview of Modular Product Development, Proc. National Science Council ROC(A) Vol. 24, No. 3, pp. 149-165
6. Marc H. Meyer and Arthur DeTore (1999) Product Development for Services, The Academy of Management Executive, Vol. 13, No. 3, Themes: Teams and New Product Development (Aug., 1999), pp. 64-76

Related Course's / Useful Link

1. https://swayam.gov.in/nd1_noc20_cs90/preview
2. <https://nptel.ac.in/courses/106/106/106106090>
3. <https://nptel.ac.in/courses/112/102/112102101>

Departmental Elective – IV

Subject Code: BAU071	Hybrid Vehicle Propulsion	L T P : 3 0 0	Credits: 3
-----------------------------	----------------------------------	----------------------	-------------------

Course Outcome: Student will be able to		Bloom Taxonomy
CO1	Understand the basics of the hybrid electric vehicles and it's types.	K2
CO2	Understand the types of drive trains used in hybrid vehicles	K2
CO3	Understand the propulsion units used in Hybrid Vehicles and their efficiency.	K2
CO4	Understand the requirements and devices of energy storage used in hybrid vehicles.	K3
CO5	Understand the concept of downsizing of IC engines in case of hybrid vehicles.	K3

UNIT-I

Introduction to Hybrid Electric Vehicles:

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

Conventional Vehicles:

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.

UNIT II

Hybrid Electric Drive-trains:

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains:

Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III

Electric Propulsion unit:

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

UNIT IV

Energy Storage:

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices.

Sizing the drive system:

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology,

UNIT V

Energy Management Strategies:

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Text Books:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. MehrdadEhsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Reference Books:

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, John Wiley & Sons Ltd., 2011.

Subject Code: BME751	Measurement & Metrology Lab	L T P : 0 0 2	Credits: 1
-----------------------------	--	----------------------	-------------------

Course Outcome : Student will be able to		Bloom Taxonomy
CO1	Understand the basic principles of instrumentation for measurement of surface finish, strain, temperature, pressure and flow.	K2
CO2	Understand the principle and operation of Coordinate Measuring Machine (CMM).	K2
CO3	Apply Sine Bar, Slip Gauges, Bevel Protractor, Stroboscope, Dial Indicator etc. for measurement of different attributes.	K3
CO4	Apply the basic concepts of limits, fits & tolerances for selective assembly.	K3

List of Experiments

Minimum 08 experiments out of following (or such experiment) are to be performed:

1. Measurement of effective diameter of a screw thread using 3 wire method.
2. Measurement of angle using sine bar & slip gauges.
3. Study of limit gauges.
4. Study & angular measurement using Bevel protector.
5. Study of different types of Comparators.
6. Study of important parameters of surface finish.
7. Study of principle and operation of coordinate-measuring machine (CMM).
8. Use of dial indicator and V Block to check the circularity and plot the polar Graph.
9. Study and understanding of limits, fits & tolerances in assembly of machine components.
10. Study and understanding of different methods of measurement of pressure.
11. Study and understanding of different methods of measurement of temperature.
12. Study and understanding of measurement of strain using strain gauges.
13. Study and understanding of different methods of measurement of flow.
14. Study and understanding of different methods of measurement of vibration/power.
15. Study and understanding of measurement of displacement using LVDT.