SYLLABUS
for
6th SEMESTER

B.TECH. DEGREE

in

MECHANICAL ENGINEERING

(Applicable from the academic session 2024-2025)

Approved by BOS(ME) dt 5.11.2024 & Academic Council, Agenda-01.02, dt 21.11.2024

Dr. B. C. Roy Engineering College

An Autonomous Institution

Approved by: All India Council for Technical Education (AICTE)

Affiliated to: Maulana Abul Kalam Azad University of Technology, West Bengal (Formerly Known as -WBUT)

Jemua Road, Durgapur, West Bengal, India,713206

Course Name: Heat Transfer
Course Code: ME 601
(Semester VI)
Course Broad Category: Professional Core

1. **Course Prerequisite:**
   Engineering Thermodynamics, and Fluid Mechanics

2. **Course Learning Objectives:**

The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation. Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations. The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

   Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. **Course Content:**
   Course Name: Heat Transfer
   Course Code: ME 601
   Hours per Week: 2L: 1T: 0P
   Credits: 3

Module	Topics	45L
1.	**Modes of heat transfer (Conduction):** Fourier law of heat conduction for isotropic material. Thermal conductivity. Derivation of general heat conduction equation. Non- dimensionalisation thermal diffusivity and Fourier number. Types of boundary conditions. Solution of steady one dimensional conduction problem with and without heat generation. Analogy with electrical circuits. Critical thickness of insulation. Fins-rectangular and pin fins. Fin effectiveness and efficiency. Lumped parameter approach and significance of time constant. Biot number Solution of I-D transient heat conduction equation without generation using product solution.	15L

2.	**Convection:** Introduction. Newton's law of cooling and significance of heat transfer coefficient. Momentum and energy equation in two-dimensions. Non-dimensionalisation and significance of non-dimensional quantities. Scale analysis for flow over flat-plate. Velocity and thermal boundary layer thickness by integral method. Natural convection-effect of coupling on the conservation equation. One dimensional solution for Couette and Poiseulli flow. Concept of developing and developed How. Correlations-forced convection for external and internal flows. Natural convection over a vertical llat-plate.	10L
3.	**Radiation:** Physical mechanism of thermal radiation. Laws of radiation. Definition of black body, emissive power. Radiation intensity. Reflectivity. transmissivity. Irradiation, radiosity. Radiation exchange between black bodies Concept of grey-difuse-isotropic surface. Exchange between GDI surfaces by radiation network method. Radiation shielding.	10L
4.	**Heat Exchangers:** Types of heat exchangers, Analysis and design of heat exchangers using both LMTD and ε - NTU methods. Pool boiling curve. D.N.B, critical heat flux. drop and film wise condensation, laminar film condensation on a vertical plate-	10L

5. References:

Text Book:

- A. Bejan, Heat Transfer, John Wiley, 1993
- J.P. Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.

Reference Books:

- F.P. Incropera and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 6th Edition, John Wiley, 2007.
- M. Kaviany, Principles of Heat Transfer, John Wiley, 2002.
- Y.A. Cengel, Heat Transfer: A Practical Approach, McGraw Hill, 2002G. B. Thomas & R.L. Finney--- Calculus and Analytic Geometry; **Publisher.** Penguin Random House Australia**.**

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME 601.1	Quantify the rate of heat transfer through simple geometries under steady and unsteady state conditions.	Demonstrate	Remember
ME 601.2	Estimate the rate of heat transfer from finned surfaces and the time of cooling or heating in transient heat conductions.	Explain	Understand
ME 601.3	Compute the heat transfer coefficients for internal and external flows under free and forced convective conditions.	Implement	Apply

ME 601.4	Heat transfer coefficients for boiling and condensation heat transfer.	Calculate	Analyze
ME 601.5	A heat exchanger using LMTD or NTU- Ɛ methods.	Using	Apply
ME 601.6	Calculate the radiation heat exchange between the surfaces and interpret the significance of radiation shields.	Calculate	Evaluate

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	1	-	2	-	-
2	2	3	-	2	-	-
3	-	1	3	3	3	3
4	-	-	-	-	3	1

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ME 601.1	3	2	2	2	1	1	-	1	1	-	1
ME 601.2	3	2	2	2	1	1	-	1	1	-	1
ME 601.3	3	2	2	2	1	1	-	1	1	-	1
ME 601.4	3	2	2	2	1	1	-	1	1	-	1
ME 601.5	3	2	2	2	1	1	-	1	1	-	1
ME 601.6	3	2	2	2	1	1	-	1	1	-	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 601.1	2	1
ME 601.2	2	1
ME 601.3	2	1
ME 601.4	2	1
ME 601.5	2	1
ME 601.6	2	1

***** End of Syllabus*****

Course Name: Power Plant Engineering
Course Code: ME 602
(Semester VI)
Course Broad Category: Professional Core Courses

1. **Course Prerequisite:**
   Thermodynamics, Heat Transfer
2. **Course Learning Objectives:**
   To familiarize students with different aspects of power plant engineering, working of power plants based on different fuels and to expose the students to the principles of safety and environmental issues.
3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

   Evaluation System –

CIA-1-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

CIA-2-40 MARKS (Class Test (Objective + Subjective)): 25Marks, Assignment: 10 Marks, Attendance: 5 Marks

END SEMESTER EXAMINATION: 60 MARKS

4. **Course Content:**
   Course Name: Power Plant Engineering
   Course Code: ME 602
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics	45L
1.	**Analysis of Steam Cycles:** Introduction to the course, Power plant layout and essential feature of Rankine cycle, Reheating and regeneration, Problems on Rankine Cycle, Combined cycle power generation, Binary vapour cycles.	8
2.	**Boilers:** Definition, classification, fire tube and water tube boilers, mountings and accessories. Draft in boilers, performance of boiler - boilers efficiency, equivalent evaporation, Losses in boilers. Coal and combustion: Properties of coal, ultimate analysis and proximate analysis, combination calculation. Green Hydrogen, Super heater, economizer and air- pre heater. Handling of coal and ash. Boiler tubes Failures.	14
	Fuel bed firing, PF firing and Fluidized bed boilers. Introduction to boiling and circulation in boilers. Power station boilers - Benson, Lamont. Supercritical and ultra supercritical boiler.	
3.	Steam turbine: i) parts and classification, ii) nozzles types, flow through nozzles and nozzle efficiency. Impulse turbine - velocity diagram, work done and blade efficiency.	11

	Turbines: Pressure compounding and velocity compounding of steam turbine. Impulse reaction turbine - Velocity diagram, degree of reaction and Parsons turbine. Governing in Steam turbine.	
4.	Condensers: Direct Contact Condenser Surface Condensers, Effect of various parameters on condenser performance, Design of condensers, cooling towers and cooling ponds.	12
	Power plant economics and other issues: Power plant economics: Load curve. load factor. utilization factor etc. Fixed and variable operating cost. Principle of load sharing.	

5.

References:

1. Nag's Power Plant Engineering, 5th Edition, De, Sudipta, McGraw Hill, ISBN: 978-9354600050, (30 July) 2021.
2. Power Plant Engineering, As per AICTE: Theory and Practice, Dipak Kumar Mandal, Somnath Chakrabarti, Arup Kumar Das, Prasanta Kumar Das, Wiley India, ISBN: 978-8126579754, (1 January 2019).
3. A Textbook of Power Plant Engineering, 5th Ed, R.K. Rajput, Laxmi Publications, ISBN: 978-8131802557, (1 January) 2016.
4. P.K. Nag, Power Plant Engineering, McGraw Hill, 2017.
5. Domkundwar, Arora and Domkundwar, Power Plant Engineering, Dhanpat Rai & Sons, New Delhi, 2016.
6. M.M. Ei-Wakil, Power Plant Technology, McGraw Hill Com., 1985.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME 602.1	**Analyze** the vapour power cycles and their modifications.	Analyze	Analyze
ME 602.2	**Understand** boilers & calculate its performance parameters.	Understand	Understand
ME 602.3	**Analyze** the combustion phenomenon of fuels.	Analyze	Analyze
ME 602.4	**Determine** the performance parameters of steam nozzles and steam turbines.	Determine	Evaluate
ME 602.5	**Illustrate** and Design the condensers and cooling towers.	Illustrate	Apply
ME 602.6	**Determine** power plant economic parameters and know about the Diesel and gas plants, pollution and its control.	Determine	Evaluate

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	1	3	2	-	-	-
3	1	-	-	3	-	-
4	1	-	-	-	3	2

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ME 602.1	2	3	2	1	1	-	1	1	1	-	1
ME 602.2	2	3	2	1	1	-	1	1	1	-	1
ME 602.3	2	3	2	1	1	-	1	1	1	-	1
ME 602.4	2	3	2	1	1	-	1	1	1	-	1
ME 602.5	2	3	2	1	1	-	1	1	1	-	1
ME 602.6	2	3	2	1	1	-	1	1	1	-	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 602.1	3	2
ME 602.2	3	2
ME 602.3	3	2
ME 602.4	3	2
ME 602.5	3	2
ME 602.6	3	2

***** End of Syllabus*****

Course Name: Mechatronics
Course Code: ME-603
(Semester VI)
Course Broad Category: Professional courses

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1. **Course Prerequisite:**
   Fluid Mechanics and Fluid Machinery, Kinematics and Theory of Machines, Basic Electrical Engineering, Basic Electronics Engineering

2. **Course Learning Objectives:**

   To provide knowledge on sensor technology, signal conditioning. To make familiar about drive systems, control system and microcontrollers in designing mechatronics system.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

   Evaluation System –

   CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,
   Attendance: 5 Marks
   CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,
   Attendance: 5 Marks
   END SEMESTER EXAMINATION: 60 MARKS

4. **Course Content:**
   Course Name: Mechatronics
   Course Code: ME-603
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics	45L
1.	**Introduction to Mechatronics**: Definition, Mechatronics in design and manufacturing, Comparison between Traditional and Mechatronic approach; Concurrent engineering	4L
2.	**Electronics and Sensor:** Review of fundamentals of electronics: Logic gates and their operations, Signal processing devices, Data conversion devices, Input and output devices. Sensors and Transducers, Actuators, Limit switches, Relays	6L

3.	**Control Systems:** Open loop and closed loop control, block diagrams, transfer functions, Laplace transforms. Mathematical modeling of physical systems, such as spring mass vibration system, linear and rotory motion and its Laplace Transform. Basics of time domain analysis, State- Space Modelling of Systems, Introduction to discrete-time systems and Z-transform.	10L
4.	**Actuators and Drives:** Electrical Drives: Stepper motors, servo drives. Mechanical Drives: Different mechanisms, Ball screws, Linear motion bearings, Transfer systems. Pneumatic and Hydraulic Drives: Elements of pneumatic and hydraulic drives, comparison between them. Design of pneumatic and hydraulic circuits, symbolic representations of such circuits indicating different valves, actuators, etc.	10L
5.	**Controllers:** Basics of 8085 microprocessor, programmable register architecture, buses, memory mapping, clock pulse and data transfer operations, and simple assembly and mnemonic programming on 8085 microprocessor. Introduction to ATMEGA328P and some other microprocessors Use of On-Off, PI and PID controllers to control different drives, Programming in PLC controller using Ladder diagram.	10L
6.	**Mechatronics System Design:** Introduction to Mechatronic systems, such as automatic brake, door closing and opening, robot, CNC machine, AGV, etc. Introduction to Industry 4.0, 5.0 and Industrial Internet of Things.	5L

5. References:

Text Book:

- William Bolton, Mechatronics, Pearson.

Reference Books:

- Gottlieb, I. M., Electric Motors and Control Techniques , TAB Books, McGraw-Hill 1994
- Kenjo, T. and Sugawara, A., Stepping Motors and their Microprocessor Controls , Clarenden Press 1995
- Norton, R. L., Design of Machinery , McGraw-Hill 2003
- Pinches, M. J. and Callear, B. J., Power Pneumatics , Prentice-Hall 1996
- I.J. Nagrath and M. Gopal, Control System Engineering, New Age International, 2009.
- Morris, A.S., Measurement and Instrumentation Principles , 3rd edition, Newnes 2001
- K. V. Shibu, Introduction to Embedded Systems, McGRAW Hill Publications (2009).

- Raj Kamal, Embedded Systems, TATA McGRAW Hill Publications (2003).
- M. A. Mazidi, R.D. Mckinlay and D. Casey, PIC Microcontrollers and Embedded Systems, Pearson Publications, (2008).
- Spasov, P., Microcontroller Technology: The 68HC11, Prentice-Hall 1992, 1996, 200
- Rohner, P., Automation with Programmable Logic Controllers, Macmillan 1996

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME-603.1	Review the basics of Electrical and electronics devices for various applications signal and data processing devices.	Review	Remember
ME-603.2	Understand the design philosophy of Mechatronics, basic principles of control engineering and sensor technology having required knowledge to analyze the system in time domain.	Understand	Understand
ME-603.3	Apply electrical and electronics devices and sensors, and different drive systems including electrical, mechanism, and pneumatic and hydraulic drives and actuators.	Apply	Apply
ME-603.4	Analyze the control systems using frequency domain analysis, stability analysis, in state space etc. and analyze the performance of drive systems, control program.	Analyze	Analyze
ME-603.5	Asses any mechatronic control system, performance of drive systems and control programs.	Assess	Evaluate
ME-603.6	Design microprocessor-microcontroller based Mechatronics control systems, PLC based systems using proper drive system.	Design	Create

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	2	-	-	-	-
2	3	2	-	-	-	-
3	1	3	-	-	3	-
4	1	-	1	-	-	3
5	1	2	3	-	-	3
6	-	-	3	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	3	-	-	-	-	-	-	-	1	-	1
CO2	2	-	3	1	-	1	-	-	-	-	1
CO3	2	-	3	1	-	1	-	-	-	-	1
CO4	2	-	3	1	-	1	-	-	-	-	1
CO5	2	-	3	1	-	1	-	-	-	-	1
CO6	2	-	3	1	-	1	-	-	-	-	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
CO1	2	3
CO2	2	3
CO3	2	3
CO4	2	3
CO5	2	3
CO6	2	3

***** End of Syllabus*****

Course Name: Advanced Manufacturing Technology
Course Code: ME-604
(Semester VI)
Course Broad Category: Engineering Science Courses

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1. Course Prerequisite:
The prerequisite for the Advanced Manufacturing Technology course is a foundational understanding of manufacturing processes, materials science, and basic principles of mechanical engineering.

2. Course Learning Objectives:
The course on Advanced Manufacturing Technology aims to equip students' within-depth knowledge of cutting-edge manufacturing techniques.

3. Teaching methodology and evaluation system for the course:
Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

Evaluation System –
CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks
CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks, Attendance: 5 Marks
END SEMESTER EXAMINATION: 60 MARKS

4. Course Content:
Course Name: Advanced Manufacturing Technology
Course Code: ME-604
Hours per Week: 3L: 0T: 0P
Credits: 3

Module No.	Description of Topic	Contact Hrs.
1	Advanced Machining Processes: Introduction: Need and comparison between traditional, non-traditional and micro & nano machining process. Process principle, Material removal mechanism, Parametric analysis and applications of processes such as Mechanical energy based processes (AJM, WJM, AWJM and USM); Electrical energy based processes (EDM &WEDM); chemical and electro-chemical energy based processes (CHM and ECM); and Thermal energy based processes (LBM, PAM, EBM).	14L
2	Advanced Welding Processes: Details of electron beam welding (EBW), laser beam welding (LBW) and ultrasonic welding (USW), Friction-stir welding.	7L
3	Advanced Casting Processes: Metal mould casting, Continuous casting, Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting	8L
4	Rapid Prototyping:	8L

	Overview of Rapid Prototyping, Basic Process- CAD Model Creation, Conversion to STL format, Slicing the STL File, Layer by layer construction.Principles,systems,relativeadvantagesandapplications of the common RP methods, such as Stereo lithography (SLG), Selective laser sintering (SLS), Fused deposition modeling (FDM), Laminated objects manufacturing (LOM), 3D Printing.	
5	Micro-Machining: Need- evolution- fundamentals and trends in micro technologies, Consequences of the technology and society- challenges to manufacturing technology- evolution of precision in manufacturing, tooling and currents scenarios, requirements and applications. Theory of micromachining- Chip formation- Size effect in micro-machining- micro-turning- micro-drilling.	8L

5. References:

Learning Resources:

1. V.K.Jain,AdvancedMachiningProcesses,AlliedPublishersPvt.Ltd.2002
2. P. K. Mishra, Nonconventional Machining, The Institution of Engineers (India) Text Book Series, Narosa Publishing House, New Delhi, 1997.
3. P.C.PandyandH.S.Shan, ModernMachiningProcesses, TataMcGrawHillPublishingCompanyLtd. New Delhi, 1980.
4. V.K.Jain, Introduction to Micromachining, Alpha Science International Limited, 2010.
5. H.El-Hofy, Advanced Machining Processes, Mc Graw-Hill, New York, 2005.
6. G.F.Benedict, Nontraditional Machining Processes, Marcel DekkerInc., New York, 1987.

6. Course Outcomes (CO):

COs	Description	Action Verb	Knowledge Level
ME-604.1	Identify different non-traditional machining processes and their applications.	Identify	Remember/ Understand
ME-604.2	Describe the basic working principles and mechanism of metal removal in USM, AJM, EDM, ECM & LBM and Assess its effectiveness in various applications	Describe	Understand
ME-604.3	Apply the knowledge of process parameters and tool selection to achieve desired joints EBW, LBW & USW	Apply	Apply
ME-604.4	Illustrate the working principles and applications of advanced casting processes.	Illustrate	Understand
ME-604.5	Discuss the working principles, process variables, and performance of rapid prototyping process	Discuss	Analyse
ME-604.6	Describe the principles of micromachining, including chip formation and size effect, and Identifythechallengesassociatedwithmicro-machininganditsapplications	Describe, Identify	Understand/ Analyse

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	1	3	-	-	-	-
2	-	-	3	-	-	-

3	-	-	-	3	-	-
4	-	-	-	-	3	-
5	-	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

COs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11
ME-604.1	3	-	-	-	-	-	-	-	-	-	2
ME-604.2	3	2	-	2	-	1	-	-	-	-	2
ME-604.3	3	-	3	1	2		-	-	-	-	2
ME-604.4	2	-	2	2	-	1	-	-	-	-	
ME-604.5	3	-	2	2	3		-	-	-	-	2
ME-604.6	3	2	-	2	-	1	-	-	-	-	2

9. Mapping to Program Specific Outcome (PSO)

COs	PSO1	PSO2
ME-604.1	3	2
ME-604.2	3	3
ME-604.3	3	3
ME-604.4	2	3
ME-604.5	3	2
ME-604.6	2	3

Course Name: Production Management
Course Code: ME-605
(Semester VI)
Course Broad Category: Humanities courses

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1. **Course Prerequisite:**
   Basic Mathematics, Basic Manufacturing Processes

2. **Course Learning Objectives:**

   The course aims to provide thorough understanding on production and operations management in industries with the objective to increase productivity and quality of products and services.

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

   Evaluation System –

   CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,
   Attendance: 5 Marks
   CIA-1-40 MARKS (Class Test (Objective + Subjective): 25 Marks, Assignment: 10 Marks,
   Attendance: 5 Marks
   END SEMESTER EXAMINATION: 60 MARKS

4. **Course Content:**
   Course Name: Production Management
   Course Code: ME-605
   Hours per Week: 3L: 0T: 0P
   Credits: 3

Module	Topics	45L
1.	**Introduction to Production and Operations Management:** Types of production systems, Process Design, Automation, The Production Manager – duties and responsibilities in manufacturing organization.	2L
2.	**Facility Capacity and Layout Planning:** Capacity and capacity planning – types of capacity, role of forecasting in capacity, optimal capacity determination, optimal capacity determination. Facility layout planning – product layout, process layout, fixed position layout, cellular layout and group technology	4L

3.	**Inventory Management System:** Types of cost, Inventory management system, EOQ model, ABC model, Monte Carlo simulation in Inventory, Managing demand uncertainty.	8L
4.	**Materials Requirement Planning:** MRP, JIT, Hybrid MRP-JIT Production System, Supply Chain Management. **Total Productive Maintenance:** Benefits of maintenance management, types of maintenance, the eight pillars of TPM.	8L
5.	**Work Design:** Work Design, - Job Design - job enlargement, rotation and enrichment, job task discretion, method analysis, principles of motion economy. Work Measurement – smapling theory, stopwatch time study, work sampling, productivity.	9L
6.	**Demand Forecasting:** Qualitative Methods of Forecasting – customer survey, sales force composite, executive opinion, Delphi method, past analogy. Quantitavie methods of forecasting – time series analysis, trend analysis. New product demand forecasting – trial purchases, repeat purchases, competitive share models.	7L
7.	**Quality Mangement:** Quality, quality of design, quality of conformance, quality of performance, the quality function, quality control, cost of quality, value of quality. Statistical Quality Control: control charts of variables, control charts of attributes, acceptance sampling.	7L

5. References:

Text Book:

- Production and Operations Management by Kanishka Bedi, Oxford University Press.
- Statistical Quality Control by Manohar Mahajan, Dhanpat Rai &Co.

Reference Books:

- Production and Operations Management |6th Edition by S N Chary McGraw Hill
- Supply Chain Management: Strategy, Planning, and Operation, by Sunil Chopra Dharam Vir Kalra , Gourav Dwivedi, 7th Revised Edition by Pearson Paperback

- Forecasting: Principles and Practice 3rd ed. Edition by Rob J Hyndman , George Athanasopoulos, Otexts
- Forecasting: Methods and Applications, 3ed Paperback by Spyros Makridakis, Steven C. Wheelwright , Rob J. Hyndman, Wiley
- Introduction To Work Study Paperback – 30 September 2015 by Geneva (Indian Adaptation) International Labour Office (Editor**),** Oxford & IBH Publishing Co Pvt.Ltd

6. Course Outcomes (CO):

Course Outcomes	**Details/Statement**	**Action Verb**	**Knowledge Level**
ME-605.1	*Understand* the types of production systems, quality and its management, MRP and TPM.	Understand	Understand
ME-605.2	*Apply* their knowledge to work design, job design and work measurement.	Apply	Apply
ME-605.3	*Design* capacity layout and facility layout.	Design	Create
ME-605.4	*Evaluate* required optimum inventory levels.	Evaluate	Evaluate
ME-605.5	*Evaluate* the forecasted demand of a product and/or service and also of a new product.	Evaluate	Evaluate
ME-605.6	*Apply* statistical quality principles for assuring quality.	Apply	Apply

7. Mapping of course outcomes to module / course content

Module	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**	**CO6**
1	3	-	-	-	-	-
2	-	-	3	-	-	-
3	-	-	-	3	-	-
4	3	-	-	-	-	-
5	-	3	-	-	-	-
6	-	-	-	-	3	-
7	1	-	-	-	-	3

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	-	-	1	1	3	1	1	1	-	1
CO2	1	-	-	3	1	2	1	1	1	-	1
CO3	1		3	2		1	1	1	1	-	1
CO4	2	1	2	1	1	1	1	1	1	-	1
CO5	2	1	2	1	1	1	1	1	1	-	1
CO6	2	1	2	1	1	1	1	1	1	-	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
CO1	2	3
CO2	2	3
CO3	2	3
CO4	2	3
CO5	2	3
CO6	2	3

***** End of Syllabus*****

Course Name: Thermal Engineering Laboratory
Course Code: ME 691
(Semester VI)
Course Broad Category: Professional Core

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1. **Course Prerequisite:**

   Concept of Basic thermodynamics.

2. **Course Learning Objectives:**

   The objective of this course to understand the principles and performance characteristics of thermal devices and to know about the measurement of the thermal properties

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Conduction laboratory experiments, correlate with theory by Interactive Discussions and Case Studies.

   Evaluation System –

   A. Internal Assessment (60 Marks) - Formative Continuous Assessment [Continuous Assessment]
   B. End-Semester Exam (40 Marks) - Summative Assessment.

4. **Course Content:**
   Course Name: Thermal Engineering Laboratory
   Course Code: ME 691
   Hours per Week: 0L: 0T: 4P
   Credits: 2

5. **List of Experiments**

   1. Study and performance test of a single acting reciprocating air compressor.
   2. Determination of the calorific value of a given fuel and its flash & fire points
   3. Determination of the thermal conductivity and specific heat of given objects
   4. Determination of thermal conductivity of an insulating powder.
   5. Determination of the heat transfer coefficient ‘h’ for forced convection and natural convection over a pin fin.
   6. Determination of the emissivity of a test plate.
   7. Study of a shell and tube heat exchanger and determination of LMTD.
   8. Determination of the p-V diagram and the performance of a 4-stroke diesel engine
   9. Performance test of a petrol engine using electrical (eddy current) and mechanical (Rope-brake) dynamometer.
   10.
       (i). Flue gas analysis by ORSAT apparatus.

(ii). Use of catalylitic converters and its effect on flue gas of an I.C. Engine.

11. Study of MPFI (multipoint fuel injection system).
12. Study of valve timing diagram of a Diesel Engine cut model.

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME 691.1	**Explore** the valve timing and the multipoint fuel injection system.	Identify	Remember
ME 691.2	**Conduction** experiments on shell and tube heat exchanger.	Conduction	Understand
ME 691.3	**Determine** the calorific value of fuels and their flash and fire points	Determine	Evaluate
ME 691.4	**Determine** the performance parameters of four-stroke petrol and Diesel engines and a reciprocating air-compressor.	Determine	Evaluate
ME 691.5	**Examine** the thermal conductivity, specific heat, emissivity and the convective heat transfer coefficient of solid and fluid materials.	Examine	Analysis
ME 691.6	**Analysis** the flue gas using ORSAT apparatus and study the effect of catalytic converters.	Examine	Analysis

7. Mapping of course outcomes to module / course content

Experiment No	CO1	CO2	CO3	CO4	CO5	CO6
1	1	-	-	2	-	1
2	2	3	-	1	-	1
3	1	3	3	2	1	1
4	1	-	-	2	1	1
5	2	-	-	1	3	1
6	-	-	-	-	-	-
7	-	-	-	-	-	-
8	-	-	1	-	-	-
9	-	-	-	3	-	-
10	-	-	-	-	-	3
11	1	-	-	-	-	-
12	3	-	1	-	-	-

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
ME 691.1	3	2	2	1	1	-	1	1	-	1	2
ME 691.2	2	3	2	1	1	-	1	1	-	1	2
ME 691.3	2	3	2	1	1	-	1	1	-	1	2
ME 691.4	3	2	1	1	2	-	1	1	-	1	2
ME 691.5	1	2	2	1	1	-	1	1	-	1	2
ME 691.6	1	2	2	1	1	-	1	1	-	1	2

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
ME 691.1	1	2
ME 691.2	1	2
ME 691.3	1	2
ME 691.4	1	2
ME 691.5	1	2
ME 691.6	1	2

***** End of Syllabus*****

Course Name: Mechatronics Laboratory
Course Code: ME-692
(Semester VI)
Course Broad Category: Professional courses

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1. **Course Prerequisite:**
   Basic Electrical Engineering, Basic Electronics Engineering

2. **Course Learning Objectives:**

   The course aims to equip the students with the skill of digital circuits, pneumatic drive system, control systems and microcontrollers for the design and fabrication of Mechatronics systems

3. **Teaching methodology and evaluation system for the course:**
   Teaching methodology – Lectures and Presentations, Interactive Discussions and Case Studies, Guest Lectures.

   Evaluation System –

A. Mid-Term Exam (60 Marks)- Summative Assessment (PCIA)
B. Practical End-Semester Examination (40 Marks) – Summative Assessment

4. **Course Content:**
   Course Name: Mechatronics Laboratory
   Course Code: ME-692
   Hours per Week: 0L: 0T: 2P
   Credits: 1

Module	Topics	30L
1.	**Logic Gate Circuits**: Experiment 1: Development of electronic circuits using logic gates.	3L
2.	**Experiments on Pneumatic Trainer :** Experiment 2: Developing pneumatic circuits and controlling manually Experiment 3: Developing electro-pneumatic circuits and control Experiment 4: Design and development of pneumatic circuits using PLC control	9L
3.	**Microprocessor and Microcontrollers:** Experiment 5: Execution of simple programs on 8085 microprocessor Control of simple devices using Arduino UNO and reading sensor data Experiment 7: Control of different motors using Arduino UNO and motor drivers	12L

	Experiment 8: Control of simple devices using Raspberry Pi and reading sensor data Experiment 9: Control of different motors using Raspberry Pi	
4.	**Control Systems:** Experiment 10: PID control of temperature Experiment 11: DC Position control	6L

5. References:

Text Book:

- William Bolton, Mechatronics, Pearson.

Reference Books:

- Gottlieb, I. M., Electric Motors and Control Techniques , TAB Books, McGraw-Hill 1994
- Kenjo, T. and Sugawara, A., Stepping Motors and their Microprocessor Controls , Clarenden Press 1995
- Norton, R. L., Design of Machinery , McGraw-Hill 2003
- Pinches, M. J. and Callear, B. J., Power Pneumatics , Prentice-Hall 1996
- I.J. Nagrath and M. Gopal, Control System Engineering, New Age International, 2009.
- Morris, A.S., Measurement and Instrumentation Principles , 3rd edition, Newnes 2001
- K. V. Shibu, Introduction to Embedded Systems, McGRAW Hill Publications (2009).
- Raj Kamal, Embedded Systems, TATA McGRAW Hill Publications (2003).
- M. A. Mazidi, R.D. Mckinlay and D. Casey, PIC Microcontrollers and Embedded Systems, Pearson Publications, (2008).
- Spasov, P., Microcontroller Technology: The 68HC11, Prentice-Hall 1992, 1996, 200
- Rohner, P., Automation with Programmable Logic Controllers, Macmillan 1996

6. Course Outcomes (CO):

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME-692.1	Design and test simple electronics circuits using logic gates	Design	Create
ME-692.2	Develop pneumatic circuits and automate the same with PLC.	Develop	Create
ME-692.3	Generate and test simple programs on 8085 microprocessor.	Generate	Create
ME-692.4	Create Mechatronics systems using microcontrollers like Arduino UNO and Raspberry Pi, and sensors, motors etc	Create	Create
ME-692.5	Analyze control system.	Analyze	Analyze
ME-692.6	Evaluate the performance of control systems.	Evaluate	Evaluate

7. Mapping of course outcomes to module / course content

Module	CO1	CO2	CO3	CO4	CO5	CO6
1	3	-	-	-	-	-
2	-	3	-	-	-	-
3	-	-	2	3	-	-
4	-	-	-	-	3	2

8. Mapping of the Course outcomes to Program Outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	1	1	3	1	1	1	-	2	1	-	1
CO2	1	1	3	1	1	1	-	2	1	-	1
CO3	1	1	3	1	1	1	-	2	1	-	1
CO4	1	1	3	1	1	1	-	2	1	-	1
CO5	1	1	3	1	1	1	-	2	1	-	1
CO6	1	1	3	1	1	1	-	2	1	-	1

9. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
CO1	3	2
CO2	3	2
CO3	2	3
CO4	2	3
CO5	2	3
CO6	2	3

***** End of Syllabus*****

Course Name: PROJECT-III

Course Code: ME-681

(Semester -VI)

Course Category: Minor

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1. Course Prerequisite:

Skills up to the previous semester level in Mechanical Engineering

2. Course Learning Objectives:

It is a research-based project that requires students to apply the knowledge and skills they have acquired during their course-work to a real-world problem or research question. The project and thesis are designed to help students develop their research skills, critical thinking, and problem- solving abilities.

- To apply the knowledge and skills acquired during the coursework to a real-world problem or research question
- To develop research skills, including literature review, research design, data collection, data analysis, and interpretation
- To develop critical thinking and problem-solving abilities
- To produce a high-quality thesis that demonstrates the student's ability to conduct independent research
- To develop communication skills, including written and oral presentation

3. Teaching methodology and evaluation system for the course:

- Regular Meetings: Regular meetings between the student and supervisor to discuss progress, provide feedback, and set goals.
- Progress Reports: The student submits regular progress reports, outlining their progress, challenges, and plans for the next stage of the project.
- Peer Review: The student's work is reviewed by peers, providing feedback and suggestions for improvement.
- Workshops and Seminars: The student participates in workshops and seminars, learning about research methods, academic writing, and presentation skills.
- Online Resources: The student has access to online resources, such as research articles, tutorials, and videos, to support their learning.
- Guest Lectures: Guest lectures from industry experts or researchers, providing insights into real-world applications and current research trends.
- Research Conferences: The student attends research conferences, presenting their research and learning from others in the field.
- Academic Writing Support: The student receives support and guidance on academic writing, including structure, style, and grammar.
- Time Management: The student receives guidance on time management, including setting goals, prioritizing tasks, and managing deadlines.
- Feedback and Evaluation: The student receives regular feedback and evaluation, including constructive criticism and suggestions for improvement.

Total Marks: 100

Passing criteria: 50% and above

- Literature review (10%)
- Research proposal (10%)
- Data collection and data analysis (15%)
- Results and discussion (15%)
- Conclusion and recommendations (10%)
- Thesis writing (20%)
- Thesis defense (20%)

4. Course Content: Course Name: Project-III Minor

Course Code: ME-681

Hours per Week: 0L:0T:4P

Credits: 2

Description	Tentative Timeline (overlapped)
1. Literature Review - Conduct a comprehensive literature review on the research topic - Identify the research gap and formulate a research question - Develop a research proposal	4weeks
2. Research Design - Develop a research design, including data collection and data analysis methods - Identify the sampling strategy and sample size - Develop a data collection plan	4weeks
3. Data Collection - Collect data using the methods identified in the research design - Ensure that the data is accurate, reliable, and valid	8 weeks
4. Data Analysis - Analyze the data using the methods identified in the research design - Identify the trends, patterns, and relationships in the data	8 weeks
5. Results and Discussion - Present the results of the data analysis - Discuss the implications of the findings - Identify the limitations of the study	4 weeks
6. Conclusion and Recommendations - Summarize the main findings of the study - Provide recommendations for future research	2 weeks

-Identify the contributions of the study to the field	
7. Report Writing - Write a high-quality thesis that demonstrates the student's ability to conduct independent research - Ensure that the thesis is well-organized, well- written, and free of errors	12 weeks)
8. Presentation - Defend the thesis in front of a panel of examiners - Answer questions and provide clarification on the research	2 weeks

5. Course Outcomes

Course Outcomes	Details/Statement	Action Verb	Knowledge Level
ME-681.1	Apply knowledge of research methodology to identify a research problem and develop a research proposal	Apply	Apply
ME-681.2	Conduct independent research and collect data	Conduct	Analyze
ME-681.3	Communicate research findings effectively through a thesis	Communicate	Understand
ME-681.4	Apply critical thinking and problem-solving skills to analyze complex data	Apply	Analyze
ME-681.5	Demonstrate expertise in a specialized area of research	Demonstrate	Evaluate
ME-681.6	Integrate knowledge and skills to produce a high-quality thesis that contributes to the body of knowledge	Integrate	Create

6. Mapping of the Course outcomes to Program Outcomes

	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1
CO1	1	1	1	1	1	-	1	3	2	-	1
CO2	1	1	1	2	1	1	1	3	1	1	2
CO3	2	1	1	2	-	1	1	3	1	1	1
CO4	2	1	1	1	1	-	1	3	1	-	2
CO5	1	1	2	1	-	1	1	3	1	-	2
CO6	1	1	1	1	-	-	1	3	1	-	2

7. Mapping to Program Specific Outcome (PSO)

	PSO1	PSO2
CO1	3	2
CO2	3	2
CO3	3	1
CO4	3	1
CO5	3	1
CO6	3	1

End of Syllabus