THERMAL ENGINEERING **Course Code : 313310**

Programme Name/s : **Mechanical Engineering/ Production Engineering**
Programme Code : **ME/ PG**
Semester : **Third / Fourth**
Course Title : **THERMAL ENGINEERING**
Course Code : **313310**

I. RATIONALE

Diploma holders in Mechanical Engineering are expected to take the responsibility for maintaining IC engines, steam boilers, steam turbines, steam condensers, cooling towers and other equipment in steam power plants. Understanding the fundamentals of thermodynamics is crucial to comprehending the operation and maintenance of these devices. This course emphasizes to build the foundation needed for this.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain thermal engineering devices for various industrial / field applications using relevant knowledge & skills related to thermal engineering.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Apply fundamental concepts of thermodynamics to various thermodynamic systems.
- CO2 - Determine various properties of steam using steam table.
- CO3 - Use suitable strategies to maintain steam boiler,steam turbine, steam condenser & cooling towers efficiently.
- CO4 - Select proper heat exchanger for given application.
- CO5 - Identify different components of an I.C. Engine.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313310	THERMAL ENGINEERING	TEG	DSC	3	-	2	1	6	3	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Explain the various thermodynamic systems & its properties with suitable example. TLO 1.2 Interpret various laws of thermodynamics. TLO 1.3 Maintain various thermodynamic devices by using laws of thermodynamics.	**Unit - I Fundamentals of Thermodynamics** 1.1 Thermodynamic system, Types of systems- Open, closed & isolated system, Extensive and Intensive properties, Process and Cycle. Thermodynamic definition of work, heat, difference between heat and work, flow work, concepts of enthalpy and entropy. 1.2 Laws of Thermodynamics - Zeroth law, first law and second law of thermodynamics. Kelvin Planks, Clausius statements. Concept of Heat engine, Heat pump and Refrigerator. 1.3 Application of Laws of Thermodynamics - Steady flow energy equation and its application to boiler, turbine, and condenser. (No Numerical Treatment on above)	Lecture Using Chalk-Board Presentations Video Demonstrations
2	TLO 2.1 Illustrate Ideal gas processes on P-V & T-S diagram. TLO 2.2 Determine work done, heat transfer, internal energy, enthalpy change for various ideal gas processes. TLO 2.3 Calculate different properties of steam using steam table.	**Unit - II Ideal Gases and Steam Fundamentals** 2.1 Characteristics gas constant and universal gas constant. Derivation of characteristics gas equation. 2.2 Ideal gas processes – Isobaric, Isochoric, Isothermal, Isentropic, Polytropic and their representation on P-V and T-S diagrams. Determination of work, heat, internal energy, enthalpy change. (only simple numerical based on above). 2.3 Steam fundamentals - Applications of steam, generation of steam at constant pressure with representation on T-H & T-S chart. Types of steam: Wet, dry, superheated steam. Properties of steam: Sensible, latent , total heat, specific Volume, dryness fraction. use of steam table. (Only simple numericals based on above). Rankine Cycle & its representation on P-V & T-S chart. (No numerical on Rankine cycle)	Lecture Using Chalk-Board Presentations Video Demonstrations

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Draw layout of steam power plant. TLO 3.2 Explain construction and working of steam turbines. TLO 3.3 Select condensers for the given situation with justification. TLO 3.4 Explain effective maintenance procedure of steam boiler, steam turbine, steam condenser and cooling tower.	**Unit - III Components of Steam Power Plant** 3.1 Introduction to steam power plant ,Components & layout of steam power plant. Steam Boiler- Definition as per IBR, function , Classification of boilers, Introduction to high pressure boiler , Construction & working of Lamont boiler & Benson Boiler. 3.2 Steam nozzle & Steam Turbines - Function , types , applications of steam nozzles. Steam turbine - Classification , Construction and working of Impulse and Reaction turbine. Need of compounding. Regenerative feed heating & bleeding of steam. 3.3 Steam condensers - Dalton’s law of partial pressure, function, classification of condensers, construction and working of surface Condenser. Sources of air leakage and its effect. 3.4 Cooling Towers - Classification of cooling towers, Construction and working of natural, forced and induced draught cooling tower. (No numerical Treatment for this unit)	Lecture Using Chalk-Board Presentations Model Demonstration Video Demonstrations Site/Industry Visit
4	TLO 4.1 Explain modes of heat transfer. TLO 4.2 Calculate heat transfer by conduction through slab & composite walls. TLO 4.3 Select suitable heat exchanger for given application.	**Unit - IV Heat Transfer & Heat Exchangers** 4.1 Modes of heat transfer - Conduction, convection and radiation. Conduction - Fourier’s law, conduction through slab & composite wall. Convection - Newton's law of cooling, natural and forced convection. Radiation - absorptivity, transmissivity, reflectivity, emissivity, black body, gray body, Stefan Boltzmann law . (Only simple numerical based on heat transfer by conduction through slab & composite wall.) 4.2 Heat Exchangers - Classification, construction and working of shell and tube, plate type heat exchanger and its applications.	Lecture Using Chalk-Board Presentations Video Demonstrations
5	TLO 5.1 Represent various air standard cycles on P-V & T-S diagram. TLO 5.2 Classify I. C. Engines. TLO 5.3 Explain construction and working of two strokes & four Stroke I.C. engine.	**Unit - V Introduction to I.C. Engine & Power Cycles** 5.1 Power Cycles – Carnot Cycle, Otto cycle, Diesel cycle, Dual Cycle and its representation on P-V and T-S diagram. (No numerical on above) 5.2 Basics of I.C. Engine – Engine terminology, Classification and application of IC engines, Construction & working of two stroke & four stroke I.C. engines (S.I. and C.I.)	Lecture Using Chalk-Board Presentations Model Demonstration Video Demonstrations

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Measure temperature, pressure, energy, discharge, using instruments such as contact type thermometer, U tube manometer, Rotameter, energy meter.	1	* Use thermometer, pressure gauge, rotameter, energy meter to measure temperature, pressure, discharge and energy.	2	CO1
LLO 2.1 Measure parameters required to determine air flow rate. LLO 2.2 Calculate actual volume of air at the suction of reciprocating air compressor.	2	* Measurement of discharge of air using air box.	2	CO2
LLO 3.1 Identify various components of fire tube boiler. LLO 3.2 Show the path of flue gases and water steam circuit.	3	* Trace the path of flue gases and water steam circuit with the help of Fire Tube boiler - Cochran Boiler	2	CO3
LLO 4.1 Identify various components of water tube boiler. LLO 4.2 Show the path of flue gases and water steam circuit.	4	*Trace the path of flue gases and water steam circuit with the help of Water Tube boiler - Babcock & Wilcox Boiler.	2	CO3
LLO 5.1 Identify various components of Boiler Mountings. LLO 5.2 Show the path of flue gases and water steam circuit.	5	*Demonstration & working of Boiler Mountings (Any Two)	2	CO3
LLO 6.1 Identify various components of Boiler accessories. LLO 6.2 Show the path of flue gases and water steam circuit.	6	*Demonstration & working of Boiler Accessories (Any Two)	2	CO3
LLO 7.1 Select turbine model for demonstration. LLO 7.2 Demonstrate the construction and working.	7	Demonstration & working of Impulse & Reaction steam turbine.	2	CO3
LLO 8.1 Select condenser model for demonstration. LLO 8.2 Identify various components of condensers.	8	Demonstration & working of condensers a. Water Cooled condensers. b. Air cooled condensers.	2	CO3
LLO 9.1 Use simulation software. LLO 9.2 Select input parameters to observe the output.	9	Observe simulation of Thermal Power Plant and write specifications of boilers, turbines, condensers and electrical generators.	2	CO3
LLO 10.1 Demonstrate the process of compounding.	10	Illustrate the methods of compounding used in steam turbine.	2	CO3
LLO 11.1 Measure parameters required to determine thermal conductivity. LLO 11.2 Determine the thermal conductivity of metallic rod .	11	*Conduct a trial on conduction set up of metallic rod and calculate thermal conductivity.	2	CO4
LLO 12.1 Measure parameters required to determine Stefan Boltzmann constant. LLO 12.2 Determine Stefan Boltzmann constant .	12	Conduct a trial on Stefan Boltzmann set up and calculate Stefan Boltzmann constant.	2	CO4

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 13.1 Identify different heat exchangers available in laboratory. LLO 13.2 Demonstrate the construction and working.	13	Identify different equipments in laboratory having heat exchangers and classify heat exchangers. Write construction and working any 03 of above heat exchangers.	2	CO4
LLO 14.1 Select the proper tools. LLO 14.2 Identify various subassemblies and accessories of engine.	14	*Assembling and dismantling of single cylinder I.C Engine.	2	CO5
LLO 15.1 Locate different components of multicylinder I.C. Engine.	15	Identify different components of multicylinder I.C. Engine and write function of each component.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Assignment

- Collect an information about Indian Boiler Regulation act.
- Collect an information about high pressure boilers used in steam power plants. Write a specification and compare each other.
- “High pressure boilers are used in steam power plants” Justify.
- Carry out comparative study of conventional cooling towers, cooling towers used in power plants and upcoming cooling tower.
- Make power point presentation including videos on heat exchangers commonly used.
- Collect an information about manufacturers of I.C. Engine with their specifications.
- Prepare a report on applications of I.C. Engine (S.I/C.I.) in various sectors.

Micro project

- Prepare a model of any one boiler / mounting/accessories with the help of suitable material.
- Prepare charts on compounding, regenerative feed heating processes of steam boiler.
- Collect various components of an I.C. engine and prepare a board model with its details.
- Prepare and present a seminar on boiler instrumentation using appropriate source of information.
- Prepare a report on a visit to Steam Power Plant on the basis of following parameters- a. Layout of power plant b. Specifications & type of – Steam boiler, steam turbine, Steam condenser & cooling tower. c. Construction & working of - Steam boiler, steam turbine, Steam condenser & cooling tower. d. Maintenance procedure of - Steam boiler, steam turbine, Steam condenser & cooling tower. e. List of various parameters controlled for smooth functioning.
- Prepare a model of any one heat exchanger with the help of suitable material.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Mercury or alcohol filled Thermometer, Pressure Gauge Range max up to 8 bars, U- Tube Manometer, Rotameter – Maximum up to 20 LPM .	1
2	Charts / Models demonstrating process of compounding.	10
3	Experimental set up for determination of thermal conductivity of metallic rod consisting of Metallic rod of suitable length adequately insulated with heating arrangements at one end, Voltage regulator, Six thermocouples on metallic rod, Arrangement for cooling other end of rod, Stop watch, Measuring Jar.	11
4	Experimental set up to verify Stefan Boltzmann law.	12
5	Different equipment in power engineering laboratory having heat exchangers.	13
6	Single cylinder I.C. engine suitable for Dismantling and assembling with necessary tool set .	14
7	Test rig of multicylinder I.C. Engine available in laboratory.	15
8	Two stage Reciprocating air compressor with intercooler test rig.	2
9	Cut section models of fire tube boilers.	3
10	Cut section models of water tube boilers.	4
11	Cut section models of various boiler mountings.	5
12	Cut section models of various boiler accessories.	6
13	Cut section models of Impulse & Reaction turbine.	7
14	Cut section models of various water cooled & air-cooled condensers.	8
15	Relevant simulation software.	9

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Fundamentals of Thermodynamics	CO1	8	2	4	6	12
2	II	Ideal Gases and Steam Fundamentals	CO2	12	4	4	8	16
3	III	Components of Steam Power Plant	CO3	13	4	6	8	18
4	IV	Heat Transfer & Heat Exchangers	CO4	6	2	4	6	12
5	V	Introduction to I.C. Engine & Power Cycles	CO5	6	2	4	6	12

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
Grand Total				**45**	**14**	**22**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- • Two-unit tests of 30 marks and average of two-unit tests. • For laboratory learning 25 Marks • For Self Larning 25 Marks

Summative Assessment (Assessment of Learning)

- • End semester assessment of 25 marks for laboratory learning. • End semester assessment of 70 marks.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	1	-	1	-	1	1			
CO2	3	1	-	1	-	1	1			
CO3	3	1	-	1	-	1	1			
CO4	3	1	-	1	-	1	1			
CO5	3	1	-	1	-	1	1			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	R.K. Rajput	Engineering Thermodynamics	Laxmi Publications, New Delhi 2007, ISBN: 978-0-7637-8272-63678
2	Mahesh M. Rathore	Thermal Engineering	Tata McGraw-Hill Education, New Delhi 2010, ISBN: 978-0-07068113-2
3	P.K. Nag	Basic and Applied Thermodynamics	Tata McGraw-Hill Education, New Delhi ISBN: 978-0070151314
4	S. Domkundwar, C.P. Kothandaraman, A. Domkundwar	A course in Thermal Engineering	Dhanpat Rai and company, New Delhi, 2004, ISBN:9788177000214
5	R.S.Khurmi & J.K.Gupta	A Textbook of Thermal Engineering	S.Chand Limited New Delhi 2022 , ISBN: 978-93-550-1054-4

Sr.No	Author	Title	Publisher with ISBN Number
6	V. Ganeshan	Internal Combustion Engines	Tata McGraw Hills, New Delhi. ISBN: 978-1-25-900619-7

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://onlinecourses.nptel.ac.in/noc24_me63/pr view	Fundamentals of thermodynamics
2	https://www.youtube.com/watch?v=3dyxjBwqF-8	Ideal Gas laws & Processes
3	https://www.youtube.com/watch?v=hoQ_hEweT_Y	Fundamentals of steam & steam formation
4	https://www.youtube.com/watch?v=-cr5vfV4YAI	Types of Boilers, Different Cycles in Boiler Operation, Boiler attachment.
5	https://www.youtube.com/watch?v=7w3Qu9KkPvo	Steam Turbine working
6	https://www.youtube.com/watch?v=IcBTfEtS84s	Surface and Jet Condensers
7	https://www.youtube.com/watch?v=Kj_NEUu2xvw	Types and Components of Cooling Tower
8	https://www.youtube.com/watch?v=TsdV_os3N40	Modes of Heat Transfer
9	https://www.youtube.com/watch?v=qO9BrKLKiLE	Types of Heat Exchangers
10	https://www.youtube.com/watch?v=H_RgFXjg-5s	Introduction & classification of I.C. Engine.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students