COURSE TITLE : THERMAL ENGINEERING
COURSE CODE : 4024
COURSE CATEGORY : B
PERIODS/ WEEK : 5
PERIODS/ SEMESTER : 75
CREDIT : 5

TIME SCHEDULE

MODULE	TOPIC	PERIODS
1	Fundamentals of thermodynamics, Thermodynamic processes	18
2	Air standard cycles. Working of IC Engines	19
3	Testing of IC Engines. Steam and its properties	19
4	Heat transfer. Heat exchangers. Air compressors.	19
TOTAL		75

Remarks based on feedback from students, faculty, industry (revision 2010):

COURSE OUTCOME :

Sl.No.	Sub	Student Will Be Able To
1	1	Understand the basics of Thermodynamics and thermodynamic processes.
	2	Appreciate the air standard cycles.
	3	Explain the working of IC Engines with PV, TS, valve timing and port timing diagrams
	4	Appreciate the testing of IC Engines.
	5	Understand the formation of steam and steam properties.
	6	Explain the heat transfer and heat exchanger.
	7	Appreciate the air compressors

SPECIFIC OUTCOME

MODULE I

1.1.0 Understand the basics of Thermodynamics and thermodynamic processes
1.1.1 Understand the scope and application of Thermal Engineering
1.1.2 Explain the terms such as Thermal Engineering, Thermo dynamics and Heat Engines
1.2.0 Appreciate the fundamentals of Thermodynamics
1.2.1 Define a system
1.2.2 Classify the systems
1.2.3 Explain the terms boundary and surroundings

1.2.4 Distinguish between intrinsic and extrinsic properties
1.2.5 Explain the terms pressure, temperature, enthalpy, entropy etc and their S.I. Units
1.2.6 Explain the term thermodynamic equilibrium
1.2.7 Describe the Quasistatic process.
1.2.8 Explain the specific heat of gases
1.2.9 Explain the Zeroth law, First law and Second laws of thermodynamics
1.2.10 Explain Boyle's law, Charles's law, Regnault's law, Joule's law and Avogadro's law
1.2.11 Derive the characteristic gas equation
1.2.12 Explain characteristic gas constant and universal gas constant
1.2.13 State the relationship between specific heats of gases
1.2.14 Apply the gas equation to solve simple problems

1.3.0 Define a thermodynamic process

1.3.1 Explain the importance of P-V diagram
1.3.2 Illustrate with p-V, T-S diagrams the thermodynamic processes such as Isochoric, Isobaric, Isothermal, Isentropic, Polytropic and throttling processes
1.3.3 Derive the expressions for the expansion work, change in internal energy, heat transferred and enthalpy change in each process listed in 1.3.2
1.3.4 Compute the expansion work, change in internal energy, Heat transferred and enthalpy change in each process

MODULE II

2.1.0 Appreciate the air standard cycles

2.1.1 Analyze the Air standard Cycles
2.1.2 Define Air standard Cycles
2.1.3 State the assumptions made in Air standard cycles.
2.1.4 Define Air standard efficiency.
2.1.5 Illustrate with P-V, T-S diagrams Carnot cycle, Otto Cycle, Diesel Cycle, Dual combustion Cycle, Joule Cycle
2.1.6 Derive the expressions for Air standard efficiency of Carnot cycle, Otto Cycle, Diesel Cycle and joule cycle.
2.1.7 Compute the air standard efficiency using standard expressions.

2.2.0 Explain the working of IC Engines with PV, TS, valve timing and port timing diagrams

2.2.1 Review the working of the petrol & diesel engines (both 2 Stroke & 4 Stroke) Explain the working of four stroke IC engine with the help of hypothetical P-V diagram.
2.2.2 Explain the Valve timing diagrams for the petrol and diesel engines. (both 2 Stroke & 4 Stroke)

MODULE III

3.1.0 Appreciate the testing of IC Engines

3.1.1 State the importance of performance testing of I.C. Engines
3.1.2 Define Indicated power, Brake Power, Friction Power, and Mechanical Efficiency
3.1.3 Define Indicated Thermal efficiency, Brake Thermal efficiency, Relative efficiency
3.1.4 Define Total fuel consumption & Specific Fuel Consumption.
3.1.5 Explain the Morse test.
3.1.6 Solve Simple problems for 3.1.2 to 3.1.5
3.1.7 Explain Heat balance sheet

3.1.8 Solve Simple problems for 3.1.7

3.2.0 Steam and its Properties

3.2.1 Understand the formation of steam and steam properties

3.2.2 List the uses of steam

3.2.3 Explain the formation of steam at constant pressure with a graph indicating the effect of pressure and temperature

3.2.4 Distinguish between wet steam, dry steam and superheated steam

3.2.5 Compute the enthalpy of wet, dry and super heated steam at the given pressure and state using steam tables

3.2.6 Compute the heat required to produce steam at given pressure and state from feed water.

3.2.7 Construct T-S and Mollier charts and represent various pressures in them

3.2.8 Determine the condition of steam, enthalpy, entropy specific volume of steam using mollier chart.

3.2.9 Understand the different parts and the working and of Steam Engine

3.2.10 Explain the working of a double acting Steam Engine with simple line sketch

3.2.11 Understand the various thermodynamic vapour cycles.

3.3.0 Recognize the use and application of Steam Nozzles

3.3.1 State the functions of a steam Nozzle

3.3.2 Explain the convergent nozzles and convergent – divergent nozzles

3.3.3 Derive the expression of velocity of steam leaving a nozzle

3.3.4 Compute the velocity of steam leaving a nozzle with the help of Mollier chart

MODULE IV

4.1.0 Explain the heat transfer and heat exchanger

4.1.1 Understand the various modes of Heat Transfer

4.1.2 Explain the three modes of heat transfer, conduction, convection and radiation

4.1.3 Explain Fourier's law of thermal conduction

4.1.4 Define Thermal conductivity

4.1.5 Simple problems on conduction through a plane wall and through a composite plane wall

4.1.6 Explain the thermal radiation – reflection, absorption and transmission

4.1.7 Define absorptivity, reflectivity and transmissivity

4.1.8 Explain the concept of a Black Body

4.1.9 Explain Stefan – Boltzman's law of total radiation

4.1.10 Explain the concept of Grey body

4.1.11 Explain Newton Rikhman equation of Thermal convection

4.1.12 Explain free convection and forced convection

4.2.0 Explain the basic principles of heat exchangers

4.2.1 Classify the heat exchangers – Recuperator type and regenerative type, parallel flow, counter flow type & cross flow.

4.2.2 Explain the concept of overall heat transfer coefficient & LMTD

4.3.0 Appreciate the air compressors

4.3.1 Explain the construction and working of Air compressors

4.3.2 State the function of an air compressor

4.3.3 State the uses of compressed air

4.3.4 Classify the air compressors

4.3.5 Explain with simple sketches the working of reciprocating (single stage and two stage) compressors, rotary (fans and blowers) compressors, centrifugal compressors and axial flow compressors.

4.3.6 State the expressions for work done on air and power required to drive compressors (single stage and two stages only) with the help of p-v diagrams (no derivation)

4.3.7 Compute the work done on air and power required to drive the compressor (single and two stage only)

4.3.8 State the functions of intercoolers

4.3.9 List the advantages of multistage compression

4.3.10 Define the efficiencies of air compressors – Mechanical efficiency, Isentropic efficiency, Isothermal efficiency & Volumetric efficiency

4.3.11 State the expression for volumetric efficiency in terms of clearance volume and stroke volume (no proof)

4.3.12 Compute the various efficiencies using the expressions mentioned in 4.1.8

4.3.13 Explain the effect of clearance on the volumetric efficiency of the compressor

GENERAL INFORMATION:

Use of Steam Tables and Mollier Charts may be permitted for Examination

CONTENT DETAILS

MODULE I

Fundamentals of Thermodynamics

Brief explanation of terms such as: Thermal Engg. – Thermodynamics - Concept of System -open- closed and isolated system - boundary- surroundings- state - properties - Intrinsic and extrinsic- pressure (absolute- atmospheric- gauge and vacuum)- temperature- S.T.P and N.T.P values- Energy- internal energy- flow work- enthalpy- entropy- specific volume- thermal equilibrium - thermodynamic equilibrium- Specific heats of gases- specific heat at constant volume - specific heat at constant pressure - their relations.

Thermodynamic Laws (Brief explanations)

1. Zeroth law 2. First law 3. Second law

Laws of perfect gases (Brief explanations)

1. Boyle's law 2. Charle's law 3. Regnault's law 4. Avogadro's law 5. Joule's law **Gas equation**

Derivation of characteristic gas equation- characteristic gas constant and universal gas constant -simple problems

Thermodynamic Processes

Explanation- p-V diagram. Derivation of equations for flow work- change in internal energy- and heat transferred for the - Isochoric process- Isobaric process- Isothermal process- Isentropic process- Polytrophic process- Throttling process - Application in simple problems

MODULE II

Air Standard Cycles

Assumption- Air standard efficiency-Brief explanation with p-V diagrams - derivation of air standard efficiency of Carnot Cycle- Otto cycle- Diesel cycle- Brief explanation of dual combustion cycle with P-V diagram (No derivation of air standard efficiency)- Simple and direct problems using standard expressions.

Working of I.C.Engines

Petrol & diesel engines (both 2 Stroke & 4 Stroke) – Working - P-V diagrams - Valve timing diagrams

MODULE III

Testing of I.C. engines

I.C.Engines - Performance - testing- Indicated power- Brake Power- Friction Power- -Mechanical Efficiency- Indicated Thermal efficiency- Brake Thermal efficiency- Relative efficiency-Total fuel consumption - Specific Fuel Consumption-Morse test for Determination of I.P. of multi-cylinder engine-Heat balance sheet- problems

Under stand the formation of steam and steam properties

steam – uses- formation of steam at constant pressure - graph indicating the effect of pressure and temperature- wet steam- dry steam - superheated steam- enthalpy of wet- dry - -T-S diagram -– simple problems(with steam table & mollier chart)- condition of steam- enthalpy- entropy - specific volume of steam - Steam Engine – working- different parts -double acting Steam Engine –working- various thermodynamic vapour cycles.

Steam Nozzles- use- application- functions - convergent - divergent -velocity of steam leaving – derivation-problems (with Mollier chart & steam table) -efficiency

MODULE IV

Heat transfer-

Heat Transfer- conduction- convection and radiation-Fourier's law of thermal conduction.-Thermal conductivity-conduction through a plane wall and through a composite plane wall-problems thermal radiation - reflection- absorption and transmission-absorptivity- reflectivity and transmissivity-concept of a Black Body-Stefan - Boltzman's law of total radiation-concept of Grey body- Newton Rikhman equation of Thermal convection-free convection - forced convection.

Heat Exchangers

Heat exchangers-Classification- Recuperator -type -regenerative type- parallel flow- counter flow type & cross flow- concept of overall heat transfer coefficient & LMTD

Air Compressors – construction - Classification - working - function - uses of compressed air - reciprocating compressors (single stage and two stage) -Classfiication - rotary compressors - fans and blowers- centrifugal compressors - axial flow compressors - work done on air and power required to drive compressors- (single stage and two stages only) - p-v diagrams (no derivation)- work done - power required to drive (single and two stage only) – intercoolers - functions - multistage compression – advantages - efficiencies - Mechanical efficiency- Isentropic efficiency- Isothermal efficiency - Volumetric efficiency - in terms of clearance volume and stroke volume (no proof)-Problems -- effect of clearance on the volumetric efficiency of the compressor.

TEXT BOOKS

1. Thermal Engineering -D.S.Kumar
2. A text book of Thermal Engineering -R.S.Khurmi&J.K.Gupta

REFERENCE

1. Thermal Engineering -P.L.Ballany
2. Elements of Heat engines volume I & II -R.C. Patel & C.J. Karamchandani
3. Elements of Mechanical Engg: - Prof: Sadhu Singh
4. Thermodynamics for engineers. - Ramalingam