CBCS SCHEME

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BME401

Fourth Semester B.E./B.Tech. Degree Examination, Dec.2024/Jan.2025
Applied Thermodynamics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.
3. Use of Thermodynamics Data hand book and Steam tables are permitted.

		Module – 1	M	L	C
Q.1	a.	Derive an expression for the air standard efficiency of an Otto cycle. Represent the processes of the cycle on P – V and T – S diagrams. List the assumptions.	12	L3	CO1
	b.	The compression ratio of a Diesel cycle is 14 and the cut off ratio is 2.2. At the beginning of the cycle, air is at 0.98 bar and 100°C. Find : i) Temperature and pressure at all the salient points. ii) Air standard efficiency.	8	L3	CO1
		OR			
Q.2	a.	Explain the Willan's line method of determining the frictional power of an IC engine.	8	L2	CO1
	b.	In a test on three cylinder, 4 – stroke IC engine with 22cm bore and 26cm stroke, the following were the observations during a trial period of one hour Fuel consumption = 8kg , Calorific value = 45,000 kJ/kg , Total revolutions of the crank shaft = 12,000 , MEP = 6 bar , Net load on brake = 1500N , Brake drum diameter = 1.8m , Rope diameter = 3cm , Mass of cooling water = 550kg , Inlet temperature of water = 27°C , Exit temperature of water = 55°C , Air used = 300kg , Ambient temperature = 30°C , Exhaust gas temperature = 310°C , Specific heat of exhaust gases = 1.1 kJ/kg K , Calculate : i) Mechanical efficiency ii) Indicated thermal efficiency. Also draw a heat balance sheet in kJ/min.	12	L3	CO1
		Module – 2			
Q.3	a.	Derive an expression for the optimum pressure ratio for maximum work output in case of an ideal Brayton cycle in terms of maximum and minimum temperature of the cycle.	10	L3	CO2
	b.	In an open cycle gas turbine plant, air enters the compressor at 1 bar and 20°C. The pressure after compression is 4 bar. The isentropic efficiency of turbine and compressor are 85% and 80% respectively. The air – fuel ratio is 90 : 1. Calorific value of fuel used to 42,000 kJ/kg. Mass flow rate of air is 3kg/s. Determine the power output from the plant and the cycle efficiency. Assume that Cp = 1kJ/kg K and r = 1.4 for air and gases.	10	L3	CO2
		OR			

Q.4	a.	With a neat sketch, explain the following methods used to improve the performance of an open cycle gas turbine plant : i) Reheating ii) Inter cooling.	12	L2	CO2
	b.	With a neat sketch, explain the working of a Ramjet and a Turbo propeller engine.	8	L2	CO2
Module – 3					
Q.5	a.	With a neat schematic diagram and T – S diagram, derive an expression for the thermal efficiency of the Rankine cycle.	8	L3	CO3
	b.	Explain the effect of the following on Rankine cycle efficiency : i) Boiler pressure ii) Condenser pressure.	4	L2	CO3
	c.	A simple ideal Rankine cycle works between the pressure of 30 bar and 0.04 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency and work ratio.	8	L3	CO3
OR					
Q.6	a.	With a neat schematic diagram and T – S diagram, briefly explain the regenerative vapour power cycle with single open feed water heater. Derive and expression for its thermal efficiency.	10	L3	CO3
	b.	A steam power plant operates on a reheat cycle. Steam in boiler at 150 bar , 550°C expands through high pressure turbine. It is reheated at constant pressure of 40 bat to 550°C and expands through low pressure turbine to a condenser at 0.1 bar. Find i) Quality of steam at turbine exist ii) Cycle efficiency iii) Steam rate in kg/Kw hr.	10	L3	CO3
Module – 4					
Q.7	a.	With a neat sketch, explain the working principle of an Ammonia vapour absorption refrigeration system.	8	L2	CO4
	b.	A 10 ton Ammonia ice plant operates between an evaporator temperature of -15°C and condenser temperature of 35°C. The Ammonia enters the compressor as dry saturated vapour. Assuming isentropic compression, determine i) mass flow rate or Ammonia ii) COP iii) Power input in KW iv) Tons of ice at -10°C produced from water at 25°C in a day. Enthalpy of fusion of ice = 334 kJ/kg , Cp = 4.187 kJ/kg K for water and Cp = 2.1 kJ/kg K for ice.	12	L3	CO4
OR					
Q.8	a.	With a neat sketch, explain the working principle of a winter air conditioning system. Represent the processes of the system on a psychrometric chart.	10	L2	CO4

	b.	It is required to design an air conditioning plant for an office room with the following conditions : Outdoor conditions = 14°C DBT , 10°C WDT , Required conditions = 20°C DBT , 60% RH , Amount of air circulation = $0.3 m^3$/min/person , Seating capacity of office = 60. The required condition is achieved first by heating and then by adiabatic humidifying. Determine : i) heating capacity of the coil in kW and the surface temperature required if the bypass factor of the coil is 0.4 ii) Capacity of the humidifier.	**10**	**L3**	**CO4**
		Module – 5			
Q.9	**a.**	Derive an expression for the volumetric efficiency of a reciprocating air compressor.	**10**	**L3**	**CO5**
	b.	Air at 1 bar and 27°C is compressed to 7 bar by a single stage reciprocating compressor according to the law $PV^{1.3}$ = C. The free air delivered was 1m3/min. Speed of the compressor is 300rpm , Stroke to bore ratio is 1.5:1. Mechanical efficiency is 85% and motor transmission efficiency is 90%. Determine i) Indicated power and Isothermal efficiency. ii) Cylinder dimensions and power of the motor required to drive the compressor.	**10**	**L3**	**CO5**
		OR			
Q.10	**a.**	Derive an expression for condition of maximum discharge through a nozzle.	**10**	**L3**	**CO5**
	b.	A convergent – divergent nozzle is required to discharge 360 kg/hr of steam. The nozzle is supplied with steam and 10 bar and 0.97 dry and discharges against a back pressure of 0.5 bar. Neglecting the effect of friction, find the throat and exit diameters. Assume the condition for maximum discharge.	**10**	**L3**	**CO5**

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