CBCS SCHEME

USN | | | | | | | | | | | **BME401**

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2024

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 Steam tables and Thermodynamic data hand book is permitted.

		Module – 1	M	L	C
Q.1	a.	With usual notations obtain an thermal efficiency of otto cycle.	6	L2	CO1
	b.	Define Explosion ration and cut off ratio.	4	L1	CO1
	c.	In a air standard diesel cycle, the compression ratio is 16. At the beginning of isentropic compression, the temperature is 15°C and pressure 0.1 MPa Heat is added until the temperature at the end of the constant pressure process is 1480°C. Calculate (i) Cutoff ratio (ii) Heat supplied per kg of air (iii) Cycle efficiency (iv) Mean effective pressure.	10	L3	CO1
		OR			
Q.2	a.	How Morse test will be carried on a 3 cylinder IC engine?	4	L1	CO1
	b.	Explain the process of combustion in CI engine.	6	L2	CO1
	c.	The following readings were recorded during a trial on a single cylinder 2 stroke diesel engine, power supplied by electric motor = 1.5 kW, rated speed = 500 rpm; net load on brake drum = 225 N; Diameter of brake wheel = 1000 mm; rate of cooling water = 13.65 kg/min ; Change in temperature of cooling water = 10°C; Fuel consumption = 2 kg / hr ; Calorific value of fuel = 43000 kJ/kg ; AF ratio = 32 : 1; Specific heat of gases = 1.006 kJ/kg K ; Exhaust gas temperature = 345°C; Ambient temperature = 25°C and pressure 1 Bar. Considering a square engine of 30 mm bore and stroke length. Determine : (i) Mechanical efficiency (ii) Brake thermal efficiency (iii) Brake specific fuel consumption (iv) Brake mean effective pressure. Also draw the heat balance sheet on % basis.	10	L3	CO1
		Module – 2			
Q.3	a.	Derive an expression of air standard efficiency of Joule cycle.	6	L2	CO2
	b.	Enumerate the differences between open and closed cycle gas turbine.	4	L1	CO2
	c.	For an actual gas turbine cycle, show that the optimum pressure ratio for maximum net work output is given by $R_P = \left(\eta_C \eta_T \frac{T_3}{T_1}\right)^{\frac{\gamma}{(2(\gamma-1)}}$.	10	L3	CO2
		OR			
Q.4	a.	Explain the working principle of jet propulsion.	3	L2	CO2
	b.	How turboprop engine works explain clearly?	7	L2	CO2
	c.	A jet propelled engine having 2 jets and working on a turbojet has a velocity of 210 m/s. When flying at an altitude of 12000 m. The density of air at this attitude is 0.172 kg/m^3. The resistance of the plane is 6670.8 N and propulsive efficiency of the jet is 50%. The overall efficiency of the unit is 18%, calorific value of the fuel is 4.895×10^4 kJ/kg. Calculate (i) Absolute velocity of jet (ii) Quantity of air compressed per min (iii) Diameter of jet (iv) Power O/P (v) Specific fuel consumption (vi) A : F ratio.	10	L3	CO2

		Module – 3			
Q.5	a.	With the help of neat sketch, explain the working of open feed water heater.	8	L2	CO3
	b.	Steam from a boiler enters a turbine at 25 bar and expands to condenser pressure of 0.2 bar. Determine the rankine cycle efficiency by neglecting pump work: (i) When steam is 80% dry at turbine inlet. (ii) When steam is saturated at turbine inlet. (iii) When steam is superheated at turbine inlet by $76.1^{\circ}C$ (iv) Represent above three processes on same TS diagram.	12	L3	CO4
		OR			
Q.6	a.	Enumerate the difference between Carnot cycle and Rankine cycle.	4	L1	CO3
	b.	Obtain an expression for air standard efficiency of Ranking cycle.	6	L2	CO3
	c.	The steam is supplied to the turbine at a pressure of 32 bar and temperature of $410^{\circ}C$. The steam then expands isentropically to a pressure of 0.08 bar. Find the dryness fraction of steam at the end of expansion and thermal efficiency of cycle. If the steam is reheated at 5.5 bar temperature of $395^{\circ}C$ and then expand isentropically to 0.08 Bar. What will be the dryness fraction and thermal efficiency of cycle?	10	L3	CO3
		Module – 4			
Q.7	a.	List out the desirable properties of refrigerant.	4	L1	CO4
	b.	Derive an expression for COP of an refrigeration system.	6	L2	CO4
	c.	Atmospheric air at a pressure of 1 Bar and temperature $-5^{\circ}C$, is drawn in the cylinder of the compressor of Bell-Coleman refrigerating machine. The air is compressed isentropically to a pressure of 5 Bar and cooled to $15^{\circ}C$ in the coder at constant pressure. It is then expanded to a pressure of 1 Bar in an expansion cylinder from where it is passed to cold chamber. Calculate the work done/kg of air and COP of the plant. Assume the cycle with isentropic compression with $\gamma = 1.4$ and polytropic expansion with n = 1.2, C_p of air as 1KJ/kgK.	10	L3	CO4
		OR			
Q.8	a.	Define (i) Sensible cabling (ii) Sensible heating	4	L1	CO4
	b.	How cooling tower plays an important role in air conditioning system?	6	L2	CO4
	c.	40 m^3 of air per minute at $31^{\circ}C$ DBT and $18.5^{\circ}C$ WBT is passed over the cooling coil whose surface temperature is $4.4^{\circ}C$. The coil cooling capacity is 3.56 Tonnes of refrigeration under the given condition of air. Determine the DBT and WBT of the air leaving the cooling coil and by pass factor.	10	L3	CO4
		Module – 5			
Q.9	a.	Why multistage compressors are preffered over a single stage compressor? Also list the advantages of multistage compressors.	4	L2	CO5
	b.	Define (i) Isothermal efficiency (ii) Adiabatic efficiency (iii) FAD	6	L1	CO5
	c.	A multistage compressor is to be designed to elevate the pressure from 1 Bar to 120 Bar such that the stage pressure ratio will not exceed 4. Determine (i) Number of stages (ii) Exact stage pressure ratio (iii) Intermediate pressure (iv) The minimum power required to compress 15 m^3/min of free air. Take n = 1.2	10	L3	CO5
		OR			
Q.10	a.	Define Critical pressure ratio, also with usual notations derive critical pressure ratio.	10	L2	CO5

	b.	A turbine having a set of 16 nozzles receiver steam at 20 Bar and 400 $^\circ$C. The pressure of the steam at nozzle exit is 12 Bar. If the discharge rate is 260 kg/min and nozzle efficiency is 90%. Calculate the cross sectional area at the nozzle exit. If the steam has a velocity of 80 m/s at entry to the nozzle, find the % increase in discharge.	10	L4	CO5

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