CBCS SCHEME

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BME401

Fourth Semester B.E./B.Tech. Degree Supplementary 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.

		Module – 1	M	L	C
Q.1	a.	Derive an expression for the thermal efficiency of an air standard diesel cycle with assumptions made.	10	L3	CO1
	b.	In CI engine working on dual combustion cycle, the pressure and temperature at the start of compression 1 bar and 27°C respectively at the end of compression the pressure reaches a value of 30 bar. 500 kJ of heat supplied per kg of air during constant volume heating and pressure become 2.8 bar at the end of adiabatic expansion. Find the ideal thermal efficiency. Take C_p = 1.003 kJ/kg-°K and C_v = 0.713 kJ/kg-°K.	10	L3	CO1
		OR			
Q.2	a.	Explain the phenomenon of combustion in SI engines.	05	L2	CO1
	b.	What are the factors affecting detonation?	05	L2	CO1
	c.	The following data were recorded in a test one hour duration on single cylinder oil engine working on 4 stroke cycle bore = 300 mm, stroke = 450 mm, fuel used = 8.8 kg, CV = 41800 kJ/kg, average speed = 200 rpm, m.e.p. = 5.8 bar, brake friction load = 1860 N, quantity of cooling water = 650 kg, temperature rise = 22°C. Diameter of the brake wheel = 1.22 m. Calculate: (i) Mechanical efficiency (ii) Brake thermal efficiency (iii) Draw heat balance sheet on hour basis	10	L3	CO1
		Module – 2			
Q.3	a.	With a neat P-V and T-S diagram, derive an expression for the efficiency of a Brayton cycle.	07	L3	CO2
	b.	With neat sketch, explain inter cooling in gas turbine.	06	L2	CO2
	c.	In a gas turbine plant working on Brayton cycle the air enters to the compressor at 0.1 MPa and 30°C. The pressure ratio is 6 and maximum cycle temperature is 900°C. If the turbine and compressor efficiency of 80% each, find the cycle efficiency. Assume C_p = 1.005 kJ/kg-°K, γ = 1.4.	07	L3	CO2
		OR			
Q.4	a.	With a neat sketch, explain the working of Ramjet and Turbopropeller engines.	10	L2	CO2
	b.	In an open gas turbine plant, air enters the compressor at 1 bar and 27°C. The pressure after compression is 4 bar. The isentropic efficiencies of the turbine and compressor are 85% and 80% respectively. Air fuel ratio is 80:1. The calorific value of the fuel used is 42000 kJ/kg. Mass flow rate of air is 2.5 kg/sec. Determine the power output from the plant and the cycle efficiency. Assume the value of C_p = 1.005 kJ/kg-K and γ = 1.14.	10	L3	CO2

Module – 3

Q.5	a.	Draw the comparisons between Carnot and Rankine vapour power cycles.	06	L2	CO3
	b.	With a sketch explain effect of boiler pressure and condenser pressure on the Rankine cycle performance.	06	L2	CO3
	c.	A steam power plant operating on Rankine cycle, receives steam at 3.5 MPa and 350°C. It is exhausted at condenser at 0.1 bar. Calculate: (i) Heat supplied per kg of steam generated in boiler. (ii) Quality of steam entering the condenser (iii) Rankine cycle efficiency (iv) Specific steam consumption	08	L3	CO3

OR

Q.6	a.	Sketch the flow diagram and corresponding T-S diagram of a reheat vapour power cycle and derive expression for reheat cycle efficiency.	08	L2	CO3
	b.	In a single feed water heater, regenerative cycle, the steam enters the turbine at a pressure of 30 bar and 400°C. The exhaust pressure of the steam is 0.1 bar. The feed water heater is open type which operates at a pressure of 5 bar, find the thermal efficiency of the cycle and specific steam consumption. Show the flow diagram; the regenerative cycle on h-s and T-S diagram.	12	L3	CO3

Module – 4

Q.7	a.	Define refrigerant. What are the desirable properties of good refrigerant?	06	L2	CO4
	b.	Explain the effect of superheating and sub-cooling with aid of T-S diagram and p-h diagrams.	06	L3	CO4
	c.	A 5 ton R-12 refrigeration plant has saturated suction temperature of –5°C. The condensation take place of 32°C. Assuming isentropic compression, find: (i) COP of the plant (ii) Mass flow rate of refrigerant (iii) Power required to run compressor in kW Take following properties of R-12.	08	L3	CO1

Pressure	Temperature	h_f kJ/kg	h_g kJ/kg	S_g kJ/kg
7.85	32°C	130.5	264.5	1.542
2.61	–5°C	-	249.3	1.557

Take C_p super heated vapour = 0.615 kJ/kg-K

OR

Q.8	a.	Explain the following processes by showing them as the psychrometric chart: (i) Sensible cooling (ii) Humidification (iii) Cooling and dehumidification (iv) Heating and humidifying (v) Adiabatic mixing of two streams of air	10	L3	CO4
	b.	For a hall to be air conditional, outdoor conditions = 40°C DBT, 20°C WBT, required conditions = 20°C DBT and 60% RH. Seating capacity of the hall = 1500, amount of outdoor air supplied = 0.3 m^3/min/person. If required conditions are achieved first by adiabatic humidification and then by cooling. Estimate: (i) Capacity of cooling coil in TR (ii) Capacity of humidifier in kg/hr.	10	L3	CO4

		Module – 5			
Q.9	**a.**	Derive an expression for minimum work input by two stage compressor with intercooling between the two stages.	**10**	**L2**	**CO5**
	b.	A single stage, double acting air compressor, required to deliver 14 m^3 of air per minute measured at 1.013 bar and 15°C. The delivery pressure is 7 bar and speed is 300 rpm. Take the clearance volume as 5% of swept volume with compression and expansion index n = 1.3. Calculate: (i) The swept volume of the cylinder (ii) Delivery temperature (iii) Indicated power	**10**	**L3**	**CO5**
		OR			
Q.10	**a.**	Explain with neat sketch convergent nozzle and convergent-divergent nozzle.	**06**	**L2**	**CO5**
	b.	Derive an expression for condition of maximum discharge through a nozzle.	**06**	**L3**	**CO5**
	c.	Dry saturated steam enters a steam nozzle at a pressure of 15 bar and is discharged at a pressure of 2 bar. If dryness fraction of steam is 0.96 dry, what will be final velocity of stem? Neglect initial velocity of steam. If 15% of heat drop is lost in friction, find the percentage reduction in final velocity.	**08**	**L3**	**CO5**

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