QP Code: RN23BTECH053 | Reg. No | | | | | | | | | | | AR 23

Gandhi Institute of Engineering and Technology University, Odisha, Gunupur
(GIET University)

B. Tech (Third Semester - Regular) Examinations, November – 2024

23BMEPC23001– Engineering Thermodynamics

(Mechanical Engineering)

Time: 3 hrs | Maximum: 60 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

		CO #	Blooms Level
Q.1.	Answer ***ALL*** questions		
a.	What do you understand by the entropy principle?	CO1	K1
b.	Explain the terms, Degree of super heat, degree of sub-cooling.	CO2	K2
c.	What is the purpose of reheating?	CO3	K1
d.	For a given compression ratio and heat addition , why Otto cycle is more efficient than diesel cycle	CO4	K2
e.	What is the purpose of inter cooling and its process?	CO5	K2

PART – B **(10 x 5 = 50 Marks)**

	Answer ***All*** the questions	Marks	CO #	Blooms Level
2. a.	50 kg of water is a 313 K and enough ice at -5°C is mixed with water in an adiabatic vessel such that at the end of the process all the ice melts and water at 0°C is obtained. Find the mass of ice required and the entropy change of water and ice. Given Cp of water = 4.2 kJ/kgK, Cp of ice = 2.1 kJ/kgK and latent heat ice = 335 kJ/kg.	6	CO2	K3
b.	Write short notes on the following (i) Exergy (ii) Anergy (iii) Irreversibility (iv) Second law efficiency (v) Low grade energy and high grade energy	4	CO2	K2
	(OR)			
c.	A vessel having a capacity of 0.05 m^3 contains a mixture of saturated water and saturated steam at a temperature of 245°C. The mass of the liquid present is 10 kg. Find the following, (i) The pressure, (ii) The mass, (iii) The specific volume, (iv) The specific enthalpy, (v) The specific entropy, and (vi) The specific internal energy	5	CO2	K3
d.	Explain steam formation with relevant sketch and label all salient points and explain every point in detail	5	CO2	K2
3.a.	A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the cycle efficiency, work ratio and specific steam consumption.	5	CO3	K3
b.	A steam power plant operates on a theoretical reheat cycle. Steam at boiler at 150bar, 550°C expands through the high pressure turbine. It is reheated at a constant pressure of 40bar to 550°C and expands through the low pressure turbine to a condenser at 0.1 bar. Draw T-s diagram. Find (i) Quality of steam at turbine exhaust (ii) Cycle efficiency (iii) Steam Rate	5	CO3	K3
	(OR)			
c.	In a single-heater regenerative cycle the steam enters the turbine at 30bar, 400°C and the exhaust pressure is 0.10 bar. The feed water heater is a direct contact type which operates at 5 bar. Find: (i) The efficiency and the steam rate of the cycle. (ii) The increase in mean temperature of heat addition, efficiency and steam rate as compared to the Rankine cycle (without regeneration). Pump work may be neglected.	6	CO3	K3
d.	Briefly explain the following cycles (i) Binary vapour cycle with schematic and T-S	4	CO3	K2

	diagrams (ii) Cogeneration plant			
4.a.	An engine works on Otto cycle. The pressure and temperature of air at beginning of the cycle are 1bar and 40°C. The compression ratio is 6. The peak pressure is limited to 50bar. The compression and expansion follow the law $pv^{1.25}$ = constant. Calculate (i) thermal efficiency of the cycle, (ii) Mean effective pressure of the cycle (iii) if working cycles per minute are 300 and cylinder diameter and stroke length are 12cm and 20cm respectively. Determine the power developed by the engine in kW. The working fluid is air.	5	CO4	K3
b.	An air standard Diesel cycle has a compression ratio of 18 and the heat transferred to the working fluid per year is 1800 kJ/kg. at the beginning of compression stroke, the pressure is 1bar and temperature is 300K. Calculate (i) the pressure and temperature at each point in the cycle (ii) thermal efficiency (iii) mean effective pressure.	5	CO4	K4
	(OR)			
c.	Briefly explain the construction and working of Vapour Compression Refrigeration (VCR) system with p-v and T-s diagrams	10	CO4	K2
5.a.	A single cylinder, single acting air compressor delivers 10 kg of air per minute from 1bar and 27°C to 6 bar. The compression follows the law $PV^{1.25}$ = constant. Determine (i) the work required to compressor and delivered per kg of air. (ii) Actual power required to run the compressor if the mechanical efficiency is 80% (iii) Heat lost through the cylinder walls per minute (iv) Isothermal efficiency	5	CO5	K4
b.	A single stage-double acting air compressor takes air at 0.98 bar and 32°C and delivers at 6.32bar. The clearance is 5% of the stroke volume. The compression and expansion follow the law $PV^{1.32}$ = constant. The air handled by the compressor is 17 m^3/min when it is measured at 1bar and 15°C. Determine (i) Temperature of air delivered (ii) Stroke volume (iii) Indicated power in kW, if it runs at 500 rpm (neglect area of piston rod)	5	CO5	K3
	(OR)			
c.	What are the advantages of multi-stage compression with inter-cooling over a single stage compression for the same pressure ratio? Explain why inter-cooling is necessary in multi-stage compression?	4	CO5	K2
d.	A two stage double acting air compressor delivers air at a rate of 1.35 kg/s. the suction pressure is 1 bar and inter-stage pressure is 7bar and delivery pressure 42bar. Air enters the LP cylinder at 17°C and cooled in the inter cooler to 32°C. The clearances in LP and HP cylinders are 6% and 8% of respective strokes. The law of compression and re-expansion is $pv^{1.21}$=constant in both cylinders. Speed of the compressor is 500 rpm. Evaluate (i) the amount of cooling water required per minute in intercooler, if rise in temperature of water is limited to 20°C. (ii) power required (iii) D and L of LP cylinder if L = D.	6	CO5	K4
6.a.	Ten kg of water at 45^{O}C is heated at const. pressure of 10 bar until it becomes superheated vapour at 300^{O}C. Find the change in volume, enthalpy, entropy and internal energy.	5	CO1	K2
b.	A rigid vessel of volume 0.86 m^3 contains 1 kg of steam at a pressure of 2 bar. Calculate the specific volume, temperature, internal energy, enthalpy and entropy of steam.	5	CO1	K2
	(OR)			
c.	Steam expands isentropically in a nozzle from 1MPa, 250^{O}C to 10kPa. The steam flow rate is 1kg/sec. Find the velocity of steam at exit from nozzle, exit area of nozzle. Neglect the velocity of steam at inlet. The exhaust steam from the nozzle flows into condenser and flows out as saturated liquid. The cooling water enters the condenser at 25^{O}C and leaves at 35^{O}C. Determine the mass flow rate of cooling water.	10	CO1	K3

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