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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E. - Mechanical Engineering

Semester End Examination; August - 2023

Applied Thermodynamics

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1:Explain the concept of air standard cycle and vapor power cycle

CO2: Explain and calculate the performance characteristics of reciprocating air compressor.

CO3:Explain the different types of refrigerating systems and Apply the knowledge of P-H chart

CO4:Calculate the performance characteristics of I.C. Engines

***Note**: **I) PART-A** is compulsory. **Two** marks for each question.*

***II) PART-B**: Answer any **Two** sub questions (from a, b, c) for a Maximum of **18 marks** from each unit.*

Q. No.	Questions	Marks	BLs	COs	POs
	I : PART - A	**10**			
1 a.	List the assumptions for the analysis of air standard cycles.	2	L1	CO1	PO1
b.	Outline the practical limitations of Carnot vapour cycle.	2	L1	CO1	PO1
c.	Define Free air delivery.	2	L1	CO2	PO1
d.	Define the unit of refrigeration.	2	L1	CO3	PO1
e.	Outline motoring test.	2	L1	CO4	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
2 a.	Derive an expression for the air standard efficiency of Otto cycle in terms of compression ratio with neat P-v and T-s representation.	9	L2	CO1	PO1
b.	In an air-standard Diesel engine cycle with a compression ratio of 14, the condition of air at the start of the compression stroke are 1 bar and 300 K. After addition of heat at constant pressure, the temperature rises to 2775 K. Determine the thermal efficiency of the cycle, net work done per kg of air and the mean effective pressure.	9	L3	CO1	PO2
c.	Determine the required air–fuel ratio in a gas turbine plant, whose turbine and compressor efficiencies are 85 and 80%, respectively. The pressure ratio and maximum temperature of the cycle are 4 and 875°C respectively. The working fluid can be taken as air (C_p = 1.0 kJ/kg K, γ = 1.4), which enters the compressor at 1 bar and 27°C. The fuel used has calorific value of 42000 kJ/kg. There is loss of 10% of calorific value in combustion chamber. Also determine the actual turbine exit temperature.	9	L3	CO1	PO2

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		Marks	Level	CO	PO
	UNIT - II	**18**			
3 a.	With the help of T-s diagram, explain the working of reheat Rankine cycle. Also deduce the expression of thermal efficiency for the same.	9	L2	CO1	PO1
b.	Steam at 20 bar, 360°C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler. If the turbine and the pump efficiencies are 0.95 and 0.8 respectively, find network and cycle efficiency.	9	L3	CO1	PO2
c.	A regenerative steam cycle operates with the steam entering the turbine at 30 bar and 500°C and is exhausted at 0.1 bar. A feed water heater (open type) is used operates at 5 bar. Calculate; (i) The thermal efficiency (ii) Steam rate of the cycle	9	L3	CO1	PO2
	UNIT - III	**18**			
4 a.	With neat sketch, explain the working of single stage single acting reciprocating air compressor. Also, mention the limitations of single stage compression compared to multistage compression.	9	L2	CO2	PO1
b.	A single-stage, double-acting reciprocating air compressor works between 1 bar and 10 bar. The compression follows the law $pV^{1.35}$ = constant. The piston speed is 200 m/min and the compressor speed is 120 rpm. The compressor consumes an indicated power of 62.5 kW with volumetric efficiency of 90%. Calculate; (i) Diameter and stroke of the cylinder (ii) Clearance volume as percentage of stroke volume	9	L3	CO2	PO2
c.	A two-stage, single-acting, reciprocating air compressor takes in air at 1 bar and 300 K. Air is discharged at 10 bar. The intermediate pressure is ideal for minimum work and perfect intercooling. The law of compression is $pV^{1.3}$ = constant. The rate of discharge is 0.1 kg/s. Calculate; (i) Power required to drive the compressor (ii) Isothermal efficiency (iii) Heat transferred in intercooler	9	L3	CO2	PO2
	UNIT - IV	**18**			
5 a.	Depict vapour compression refrigeration cycle in P-h and T-s coordinates. Also, explain the function of each component in a simple vapour compression refrigeration system.	9	L2	CO3	PO1

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		Marks	BL	CO	PO
b.	With neat sketch, explain the working of steam jet refrigeration system.	9	L2	CO3	PO1
c.	A refrigerator used R-12 as a working fluid and it operates on an ideal vapour compression cycle. The temperature of refrigerant in the evaporator is – 20°C and in the condenser is 40°C. The refrigerant is circulated at the rate of 0.03 kg/s. Determine the coefficient of performance and capacity of refrigeration plant in the TR.	9	L3	CO3	PO2
	UNIT - V	**18**			
6 a.	With neat sketch, explain air box method to determine air consumption in an engine.	9	L2	CO4	PO1
b.	In a test of a single-cylinder, four stroke Diesel engine, the following data were recorded: Indicated mean effective pressure = 755 kPa, cylinder diameter = 10 cm, piston stroke = 15 cm, engine speed = 480 rpm, brake wheel diameter = 62.5 cm, net load on the brake wheel = 170 N Calculate; (i) Indicated power (ii) Brake power (iii) The mechanical efficiency of the engine	9	L3	CO4	PO2
c.	A test on single cylinder, 4-stroke Diesel engine, having bore 180 mm and stroke 360 mm gave the following results: speed 290 RPM, brake torque 392 Nm, indicated mean-effective-pressure 7.2 bar, fuel consumption 3.5 kg/h, cooling water flow 270 kg/h, cooling water temperature rise 36°C, air-fuel ratio is 25, exhaust gas temperature 415°C, barometric pressure, 1.013 bar, room temperature 21°C. The fuel has calorific value of 45,200 kJ/kg. Calculate; (i) The indicated thermal efficiency (ii) The volumetric efficiency based on atmospheric conditions. Draw up a heat balance sheet in terms of kJ/min. R = 0.287 kJ/kg°K, C_p for dry exhaust gases = 1.0035 kJ/kg-K.	9	L3	CO4	PO2

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