U.S.N | | | | | | | | | | |

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; Sep. / Oct. - 2023

Applied Thermodynamics

Time: 3 hrs *Max. Marks: 100*

Course Outcomes

The Students will be able to:

CO1: Apply the knowledge of thermodynamics to describe the different thermodynamic cycles.

CO2: Apply the basic principles of thermodynamics to describe the working of mechanical systems involving various power producing and power absorbing machines.

CO3: Analyze the performance of air standard cycles and vapor power cycles.

CO4: Analyze the performance parameters of air compressors, refrigerators and 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.	Draw P-V diagram of Brayton cycle.	2	L1	CO1	PO1
b.	Compare Carnot cycle with Rankine cycle.	2	L1	CO1	PO1
c.	State the advantages of multistage compression.	2	L1	CO2	PO1
d.	What are the desirable properties of good refrigerants?	2	L1	CO2	PO1
e.	Explain the following terms: i) Rich mixture ii) Lean mixture	2	L1	CO4	PO1
	II : PART - B	**90**			
	UNIT - I	**18**			
2 a.	Obtain an expression for air standard efficiency of a diesel cycle.	9	L2	CO1	PO1
b.	In air standard Otto cycle, the compression ratio is 6.5 and the compression begins at 1 bar and 313 K. The heat added is 2520 kJ/kg. Find; i) The maximum temperature and pressure of the cycle ii) Work done per kg of air iii) Cycle efficiency	9	L3	CO3	PO2
c.	The air enters the compressor of an open cycle constant pressure gas turbine at a pressure of 1 bar and temperature of 20°C. The pressure of the air after compression is 4 bar. The isentropic efficiencies of compressor and turbine are 80% and 85% respectively. The air fuel ratio used is 90:1. If flow rate of air is 3.0 kg/s. Find; i) Power developed ii) Thermal efficiency of the cycle Assume C_p = 1.0 kJ/kgK and γ = 1.4, CV = 41800 kJ/kg.	9	L3	CO3	PO2
	UNIT - II	**18**			
3 a.	With a schematic diagram, explain the working of Rcheat vapour power cycle and deduce an expression for cycle efficiency.	9	L2	CO1	PO2

b.	Rankine cycle working between a boiler pressure of 30 bar and condenser pressure of 0.5 bar. The mass leaving the boiler and entering the turbine have a fraction of 0.85. Determine the following; i) Rankine cycle efficiency ii) Turbine work iii) Pump work	9	L3	CO3	PO2
c.	The steam power plant working on Rcheat Rankine cycle, having boiler pressure 200 bar and 500°C, Pressure in condenser is 0.15 bar. Determine the following; i) Intermediate pressure ii) Efficiency iii) Effectiveness	9	L3	CO3	PO2
	UNIT - III	**18**			
4 a.	Derive an expression for minimum network required by a two stage air compressor with prefeat inter cooling between stages.	9	L2	CO2	PO1
b.	A reciprocating compressor of single stage, double acting type delivers 20 m^3/min when measured at free air condition of 1 bar, 27°C. The compressor has pressure of 7 bar and the condition at the end of the suction are 0.97 bar, 35°C. Compressor runs at 240 rpm with clearance volume of 5% of swept volume. The L/D ratio is 1.2. Determine the volumetric efficiency and dimensions of cylinder and isothermal efficiency taking the index of compression and expansion as 1.25. Also show the cycle on P-V diagram.	9	L3	CO4	PO2
c.	In a two stage reciprocating air compressor 1.5 kg/min of air is compressed from 1 bar to 25 bar and the index of compression is 1.2. If the work of compression is minimum and the air is cooled in the intercooler so that its temperature of 15°C, determine; i) Heat rejected during compression, ii) Heat rejected in the intercooler and iii) The power required to drive the compressor. Take for air C_p= 1 kJ/kgK and C_v= 0.714 kJ/kgK.	9	L3	CO4	PO2
	UNIT - IV	**18**			
5 a.	Explain how super heating and sub cooling of refrigerant affects the COP of vapour compression refrigeration system.	9	L2	CO2	PO1
b.	A simple vapour compression plant produces 5 tonnes of refrigeration. The enthalpies of the working fluid at inlet to the compressor, at exit of compressor and at exit from the condenser are 183.19 kJ/kg, 209.41 kJ/kg and 74.59 kJ/kg respectively. Estimate; i) The refrigerant flow rate ii) COP of the plant iii) Power required to drive the compressor iv) The rate of heat rejection in the condenser	9	L3	CO4	PO2

Contd…3

c.	Atmospheric air at 101.325 KPa has 30°C DBT and 15°C DPT. Without using the psychometric chart, using the property values from the tables Calculate; i) Partial pressure of air and water vapour ii) Specific humidity iii) Relative humidity iv) Vapour density v) Enthalpy of moist air	9	L3	CO4	PO2
	UNIT - V	**18**			
6 a.	Explain the following: i) Morse Test Method ii) Willan's Line method	9	L2	CO1	PO1
b.	A six cylinder gasoline engine operates on four stroke cycle. The bore of each cylinder is 80 mm and stroke 100 mm. The clearance volume per cylinder is 70 cc. At a speed of 4000 rpm the fuel consumption is 20 kg/hr and the torque developed is 150 Nm, calculate; i) Brake power ii) Brake mean effective pressure iii) Break thermal efficiency CV = 43000 kJ/kg iv) Relative efficiency. Take $\gamma = 1.4$ for air	9	L3	CO4	PO2
c.	A two stroke diesel engine was motored when meter reading was 1.5 kW. Test on engine was carried for one hour and data observed were as follows: Brake torque = 120 N-m, C_p(gas) = 1.05 kJ/kgK, Speed = 600 rpm, Room temperature = 27°C, fuel used 2.5 kg, A:F ratio = 32:1, CV = 40.3 MJ/kg, Cooling water = 818 kg, Rise in temperature of cooling water = 10°C, Exhaust gas temperature = 347°C. Determine; i) BP ii) IP iii) BTE and draw the heat balance sheet on minute basis	9	L3	CO4	PO2

* * * *