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

(An Autonomous Institution affiliated to VTU, Belagavi)

Fourth Semester, B.E - Industrial and Production Engineering

Semester End Examination; July/August - 2022

Engineering Thermo Dynamics

Time: 3 hrs *Max. Marks: 100*

Course Outcome

The Students will be able to:

CO1: Explain Working of IC Engines, Refrigerator and Air Conditioner, and to Explain Thermodynamic system and Properties like equilibrium, Quasistatic process, Zeroth law of thermodynamics etc.

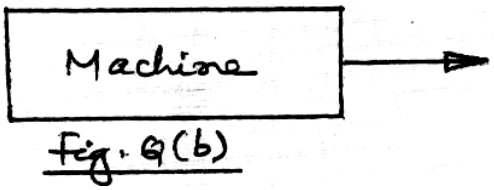
CO2: Apply first and second laws of Thermodynamics to the real world engineering devices knowing fully the limitations of energy conversion.

CO3: Identify and explain the properties of Pure Substance and Perfect Gas.

CO4: Explain different Power cycles like Carnot cycle, Rankine cycle, Efficiency, Effect of pressure and temperature on Rankine cycle, Reheat and Regenerative cycles, Air standard cycles-Otto, Diesel, Dual cycles, P-v and T-s diagrams,

CO5: Recognize the working of gas turbines and air compressor.

Note: *i) **PART-A** is compulsory. One question from each unit for maximum of 2 marks.*
*ii) **PART-B** Answer any **TWO** sub questions (from a, b, c) from each unit for a Maximum of 18 marks.*

Q. No.	Questions	Marks	BLs	COs
	I: PART - A	**10**		
1. a.	A system changes its state from state 1 to 2 through a series (i) equilibrium and represent these on any thermodynamic co-ordinate system and name them.	2	L1	CO1
b.	Identify the machine shown in fig. Q(b) Does this machine exist?  fig. Q(b)	2	L2	CO2
c.	Define quality of steam.	2	L1	CO3
d.	What do you understand by Steam rate as applied to steam turbine? Write its units.	2	L1	CO4
e.	Represent the indicator diagram for a single stage, single stroke air compressor with clearance on a PV plane and show the clearance and swept volume.	2	L1	CO5
	II: PART - B	**90**		
	UNIT - I	**18**		
1 a.	Represent any quasistatic process-12 on a PV diagram. How do you find the work done during this process? Assuming that the pressure and volume during this process is related by the equations PV^n = constant, derive an expression for the work done.	9	L3	CO1

Contd…2

b. Differentiate between:
i) Microscopic and Macroscopic view points
ii) Process and Path
(iii) Path function and Point functions — 9 L1 CO1

c. In a piston cylinder arrangement, 2 kg of air at a pressure of 1 bar and volume 0.2 m^3 expands under constant pressure to a volume of 0.8 m^3. It then undergoes a constant volume process in such a manner that under isothermal compression which follows after constant volume process, the air returns to its initial state. Represent the cycle on a PV coordinate system and determine the network done by the system. — 9 L3 CO1

UNIT - II **18**

2 a. Fig. Q2(a) shows two state points '*a*' and '*b*' on a PV diagrams. Reproduce this figure in your answer script and answer the following:
i) How states 'a' and 'b' are identified on this diagram?
ii) If a closed system changes its state from *a* to *b* quesi-statistically. Represent the same on the diagram and indicate the work done by shading the appropriate area under the curve, write the first law of thermodynamics as applicable to this process and explain the terms.
iii) If an open system (control volume) changes its state from a to b, along the same path, the work done by shading the appropriate area under the curve; write the first law of thermodynamics as applied to this flow process and explain the terms — 9 L CO2

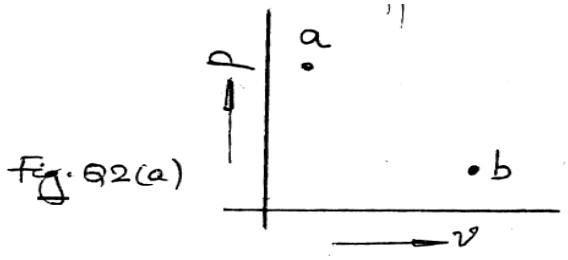


Fig. Q2(a)

b. An inventor claims to have produced an engine working as shown in fig Q2(b)

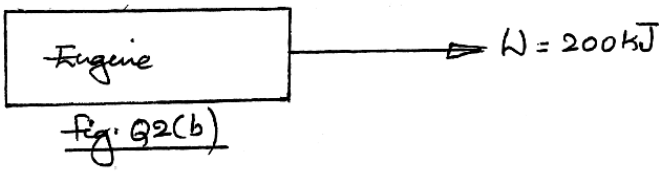


Fig. Q2(b) — 9 L CO2

(i) Is his claim viable?
(ii) If your answer is '*no*' to the above, modify the same satisfying the two laws of thermodynamics and find the efficiency of the new engine

Contd...3

c.	A heat pump provides 8.33 kJ/sec of heat to maintain a dwelling at 23ºC on a day when the outside temperature is 0ºC. The power input to the heat pump is 4 kW. Determine the COP of the heat pump and compare it with the COP of a reversible heat pump operating between the reservoirs at the same two temperatures.	9	L	CO2
	UNIT - III	**18**		
3 a.	Define the following: i) Saturation Point ii) Sub cooled liquid iii) Super heated vapour iv) Critical point Mark the above points/ regions on a vapour done represented on a T-S plane for a pure substance like water.	9	L1	CO3
b.	Representing a reversible adiabatic process exerted by an ideal gas on a T-S plane, write the governing equations for the same. Based on this equations, prove further that TV^{n-1} = constant.	9	L3	CO3
c.	A vessel contains 3 kg of water of 200°C. If the volume of vessel is 0.3 m^3. What is the condition of the given working substance? Further determine; i) Pressure ii) Specific enthalpy iii) Specific entropy of water	9	L3	CO3
	UNIT - IV	**18**		
4 a.	Representing a single state reheat Rankine cycle on a T-S plane, explain its working. Write expression for its efficiency and steam rate.	9	L1	CO4
b.	Define the following as applicable to Gas power cycles: i) Air standard efficiency ii) Mean effective pressure Derive an expression for air standard efficiency of Otto cycle with usual notations presenting the same on a T-S plane.	9	L1	CO4
c.	An ideal diesel engine has a diameter of 15cm and stroke of 20 cm. The clearance volume is 10% of the swept volume. Determine the compression ratio and air standard efficiency of the engine if the cut-off takes place at 6% of the stroke. Represent the cycle on a T-S plane.	9	L3	CO4
	UNIT - V	**18**		
5 a.	Derive an expression for air standard efficiency of 'Brayton cycle' with usual notations representing the same on T-S and P.V. planes. List the different methods used for improving the efficiency of the same.	9	L3	CO5

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b.	What is the need for staging the compression? Explain briefly substantiating with an appropriate P.V. diagram. Representing a two stage compression process with clearance on a P.V plane. Show the saving in work. Represent also the isothermal line.	9	L1	CO5
c.	An air compressor compresses air from 0.98 bar 20°C to 9.8 bar according to the law $PV^{1.2}$ = constant and delivers it to a receiver at constant pressure. Compute i) Temperature of air at the end of compression ii) Work required during compression of 1 kg of air	9	L3	CO5

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