

(2)

Code : 021307

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THERMODYNAMICS

Time : 3 hours

Full Marks : 70

Instructions :

- (i) All questions carry equal marks.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No. 1 is compulsory.
- (v) Use of Tables and Charts is permitted.

1. Write True or False from any seven of the following :

- (a) The first law of thermodynamics states that heat cannot flow from lower temperature to higher temperature without the aid of an external agency.
- (b) The displacement work is equal to $\int PdV$.
- (c) Otto cycle consists of two constant volumes and two adiabatic processes.

- (d) For same maximum pressure and heat input the thermal efficiency of otto cycle is more than that of diesel cycle.
- (e) Gases have two specific heats.
- (f) A process will be reversible if it involves friction.
- (g) The efficiency of a Carnot engine depends on the temperatures of source and sink.
- (h) When a vapour condenses into a liquid its temperature remains constant.
- (i) For saturated air WBT is more than DPT.
- (j) On psychrometric chart DPT lines are vertical.

2. (a) Derive an expression of displacement work for the following quasistatic processes :
- (i) Isothermal process
 - (ii) Polytropic process
- (b) Distinguish between the following :
- (i) Closed and Open system
 - (ii) Intensive and Extensive property
 - (iii) Point and Path function

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3. Air at a temperature of 15°C passes through a heat exchanger at a velocity of 32 m/s , where its temperature is raised to 810°C . It then enters a turbine with the same velocity of 32 m/s and expands until the temperature falls to 640°C . On leaving the turbine the air is taken at a velocity of 60 m/s to a nozzle where it expands until the temperature has fallen to 500°C . If the air flow rate is 2 kg/s , calculate the—

- (a) rate of heat transfer to the air in the heat exchanger;
- (b) power output from the turbine assuming no heat loss;
- (c) velocity at exit from the nozzle assuming no heat loss.

4. (a) State and explain both the statements of second law of thermodynamics and prove that they are equivalent.

(b) Show that the COP of a heat pump is greater than the COP of a refrigerator by unity.

(c) What is PMMZ?

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5. A perfect gas of molecular weight 29.79 occupies a volume of 0.3 m^3 at 8 bar and 270°C . The gas is allowed to expand against a piston in the cylinder till 1 bar in the following manners :

- (a) Hyperbolically
- (b) Adiabatically ($\gamma = 1.39$)
- (c) Polytropically ($n = 1.25$)

What will be the amount of heat transfer and change in entropy during expansion?

Represent the above processes on P - V and T - S planes.

5. (a) Why do the isobars on Mollier diagram diverge from one another?

(b) A steam boiler initially contains 5 m^3 of steam and 5 m^3 of water at 1 MPa . Steam is taken out at constant pressure until 4 m^3 of water is left. What is the heat transferred during the process?

7. (a) Why is Carnot cycle not practicable for a steam power plant?

(b) A heat engine working on the Rankine cycle uses steam at 20 bar dry saturated. The condenser vacuum is 540 mm of mercury. Barometer reading is 760 mm of mercury. Find Rankine cycle efficiency and work ratio.

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8. (a) How does the thermal efficiency of an air standard diesel cycle vary with compression and cut-off ratio?
- (b) A diesel cycle has compression ratio 14 and heat supply up to 5% of the stroke. Calculate the air standard efficiency of the cycle. If the compression ratio is increased from 14 to 19 and the cut-off is adjusted to give the same air standard efficiency obtained above, find the required change in the cut-off.
9. (a) What do you understand by DBT, WBT, DPT, relative humidity and humidity ratio?
- (b) What is the difference between WBT and thermodynamic WBT?
- (c) Represent the following processes on psychrometric chart :
- (i) Sensible cooling and heating
 - (ii) Humidification and dehumidification
 - (iii) Adiabatic saturation
