

BACHELOR OF ENGINEERING (CIVIL ENGINEERING) FIRST YEAR FIRST SEMESTER
SUPPLEMENTARY EXAMINATION 2023

Thermodynamics and Heat Power

Time: - 3 Hours

Full Marks:-100

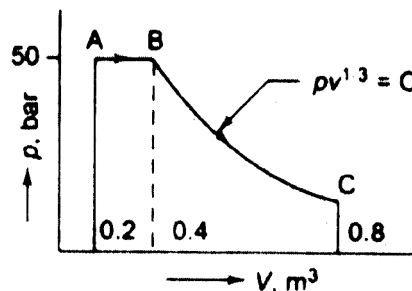
Answer any five questions

*All parts of the same question must be answered together
Data, consistent with the problem may be assumed if necessary*

1. Answer the following questions: 20
 - a) Define the terms: Thermodynamic systems, Phase and Pure substance.
 - b) What is PMMI? Why it is impossible?
 - c) Define specific heat at constant volume and constant pressure.
 - d) What is Air standard cycle?
 - e) What is the function of a fusible plug in a fire tube boiler?

2. a) Explain with neat sketches the working of a 2-stroke SI engine. 10
 b) An engine working on the Otto cycle has an air standard cycle efficiency of 56% and rejects 544 kJ/kg of air. The pressure and temperature of air at the beginning of compression are 0.1 MPa and 60°C respectively. Compute (a) the compression ratio of the engine, (b) the work done per kg of air, (c) the pressure and temperature at the end of compression, and (d) the maximum pressure of the cycle. 10

3. a) What do you mean by displacement work? Derive an expression of displacement work in an isothermal process. 10
 b) Determine the total work done by a gas system following an expansion process as shown in the figure below. 10



4. a) Define the following terms: Steam nozzle, Diffuser, Throttle valve. Derive an expression of exit velocity for flow through steam nozzle. 10
 b) In a gas turbine unit, the gases flow through the turbine is 15 kg/s and the power developed by the turbine is 12MW. The enthalpies of gases at the inlet and outlet are 1260 kJ/kg and 400 kJ/kg respectively. The velocity of gases at the inlet and outlet are 50 m/s and 110 m/s respectively. Calculate: (i) The rate at which heat is rejected to the turbine, (ii) the area of the inlet pipe given that the specific volume of the gases at the inlet is 0.45 m³/kg. 10

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- 5 a) Prove that the violation of Kelvin-Plank statement leads to the violation of Clausius statement. 8
- b) Two reversible heat engines A and B are arranged in series. A rejecting heat directly to B . Engine A receives 200 kJ at a temperature of 421°C from a hot source, while engine B is in communication with a cold sink at a temperature of 4.4°C . If the work output of A is twice that of B , find (i) the intermediate temperature between A and B , (ii) the efficiency of each engine, and (iii) the heat rejected to the cold sink. 12
- 6 a) Why is the Carnot cycle on T-s (Temperature- Entropy) plot a rectangle? 5
- b) Establish the Clausius's theorem. 7
- c) 3.5 kg of water at 85°C is mixed adiabatically with 5kg of water at 25°C in a constant pressure process of 1 atmosphere. Find the increase in the entropy of the total mass of water due to the mixing process. (C_p of water 4.187 kJ/kg K) 8
7. Write short notes on the following (*any four*): 20
- a) Thermodynamic equilibrium, b) Entropy principle, c) Reversible process, d) Heat engine, e) 1st law of thermodynamics