

B.TECH
(SEM IV) THEORY EXAMINATION 2022-23
APPLIED THERMODYNAMICS

Time: 3 Hours

Total Marks: 100

Note: Attempt all Sections. If require any missing data; then choose suitably. Use of steam table is permitted.

SECTION A

1. Attempt all questions in brief.

2 x 10 = 20

- (a) Draw P-V and T-s Diagrams for Otto cycle.
- (b) What do you mean by compression ratio and expansion ratio?
- (c) What do you mean by Vapour power cycle?
- (d) Draw P-v and T-S diagrams for Rankine cycle.
- (e) Differentiate between mountings and accessories.
- (f) What is the significance of condenser?
- (g) What is the function of Nozzle?
- (h) Define super saturated flow.
- (i) Draw regenerative gas turbine cycle.
- (j) Write short notes on intercooling and stage efficiency.

SECTION B

2. Attempt any three of the following:

10x3=30

- (a) A Diesel cycle operates at a pressure of 1 bar at the beginning of compression and the volume is compressed to $\frac{1}{16}$ of the initial volume. Heat is supplies until the volume is twice that of the clearance volume. Calculate the mean effective pressure of the cycle. Take for air $C_p = 1.005$ KJ/KgK, $C_v = 0.718$ KJ/KgK and $R = 0.287$ KJ/KgK.
- (b) A sample of fuel has the following percentage composition: C= 86%; H₂= 8%; S=3%; O₂= 2% and ash=1%. For a Air/fuel ratio of 12:1, calculate:
 - (i) Mixture strength as percentage rich or weak.
 - (ii) Volumetric analysis of the dry products of combustion.
- (c) State the function of economizer and air preheater. Also indicate suitable location of superheater, economizer and air preheater in the path of flue gases in boiler with line diagram.
- (d) Determine the mass flow rate of steam through a nozzle having isentropic flow through it. Steam enters nozzle at 10 bar, 500°C and leaves at 6 bar. Cross-section area at exit of nozzle is 20 cm². Velocity of steam entering nozzle may be considered negligible. Show the process on h-s diagram also.
- (e) Write short notes on:
 - (i) Turbojet and turboprop engines
 - (ii) Propulsive power and propulsive efficiency

SECTION C

3. Attempt any one part of the following:

10x1=10

- (a) An engine working on the Otto cycle is supplied with air at 0.1 MPa, 35°C. The compression ratio is 8. Heat supplied is 2100kJ/Kg. Calculate the maximum pressure and temperature of the cycle. The cycle efficiency and the mean effective pressure. (For air $C_p = 1.005$ kJ/KgK, $C_v = 0.718$ kJ/KgK and $R = 0.287$ kJ/KgK).
- (b) Derive an expression for the efficiency of Diesel cycle.

- 4. Attempt any one part of the following: 10x1=10**
- (a) A reheat Rankine cycle using water as the working fluid operates between the pressure limits of 7.5 kPa and 17.0 MPa. Steam is superheated to 550 °C before it is expanded to the reheat pressure of 4.0 MPa. Steam is reheated to a final temperature of 550 °C. Determine:
- (a) the cycle thermal efficiency;
 - (b) the steam rate (specific steam consumption);
- (b) Explain different types of combined cycles. Give the advantage also.
- 5. Attempt any one part of the following: 10x1=10**
- (a) A boiler may have waste gases leaving the installation when artificial draught is used at 150°C. The natural draught chimney is of 60 m height. The hot gases within chimney are at temperature of 300°C and air requirement is 19 kg per kg of fuel burnt. The atmospheric air is at 17°C temperature and mean specific heat of hot gases is 1.0032 kJ/kg K. The calorific value of fuel burnt is 32604 kJ/kg. Determine
- (i) the draught produced in mm of water
 - (ii) the efficiency of chimney
 - (iii) the extra heat carried away by flue gases per kg of fuel.
- (b) Define boiler draught. Obtain the expression for the natural draught in terms of height of water column. Also state the assumption made.
- 6. Attempt any one part of the following: 10x1=10**
- (a) What are the losses in steam turbine? What are the governing methods of steam turbine? Explain.
- (b) In a single stage impulse turbine the isentropic enthalpy drop of 200 kJ/kg occurs in the nozzle having efficiency of 96% and nozzle angle of 15°. The blade velocity coefficient is 0.96 and ratio of blade speed to steam velocity is 0.5. The steam mass flow rate is 20 kg/s and velocity of steam entering is 50 m/s. Determine
- (i) the blade angles at inlet and outlet if the steam enters blades smoothly and leaves axially.
 - (ii) the blade efficiency
 - (iii) the power developed in kW
 - (iv) the axial thrust.
- Solve using velocity diagram.
- 7. Attempt any one part of the following: 10x1=10**
- (a) What is gas turbine and how does it differ from a steam turbine? Show the influence of reheating and regeneration on performance of gas turbine cycle.
- (b) A gas turbine unit receives air at 1 bar, 300 K and compresses it adiabatically to 6.2 bar. The compressor efficiency is 88%. The fuel has a heating value of 44186 kJ/kg and the fuel-air ratio is 0.017 kg fuel/kg of air. The turbine internal efficiency is 90%. Calculate the work of turbine and compressor per kg of air compressed and thermal efficiency. For products of combustion $c_p = 1.147$ kJ/kg K, $\gamma = 1.33$.