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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 — 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%; H_2= 8%; S=3%; O_2= 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. Steamenters nozzle at 10 bar, 500°C and leaves at 6 bar. Cross-section area at exit of nozzle is 20 cm^2. 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 compresstion 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. Thecompressor efficiency is 88%. The fuel has a heating value of 44186 kJ/kg and the fuel-air ratio is0.017 kg fuel/kg of air. The turbine internal efficiency is 90%. Calculate the work of turbine andcompressor per kg of air compressed and thermal efficiency. For products of combustion cp = 1.147 kJ/kg K, γ = 1.33.