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B.Tech.
(SEM. IV) THEORY EXAMINATION 2017-18
APPLIED TERMODYNAMICS

Time: 3 Hours ***Total Marks: 70***

Note: 1. Attempt all Sections.

2. If require any missing data; then choose suitably.

3. Use of Steam Tables and Mollier chart is permitted.

SECTION A

1. Attempt *all* questions in brief. **2 x 7 = 14**

a. Write the difference between the Otto cycle and Diesel cycle.

b. What is meant by cogeneration in steam power plant?

c. Enumerate the characteristics of good fuel.

d. How equivalent evaporation is used for comparison of boilers?

e. Define degree of reaction and state point locus.

f. What is enthalpy of formation?

g. Differentiate between gas turbine and I.C. engine.

SECTION B

2. Attempt any *three* of the following: **7 x 3 = 21**

a. The following data relates to two stroke oil engine during the trial: Room temperature = 21℃, bore = 20 cm, stroke = 26 cm, speed = 400 rpm, brake drum diameter = 120 cm, rope diameter = 3 cm, net brake load = 460 N, indicated mean effective pressure = 2.8 bar, oil consumption 3.7 kg/h, calorific value of oil = 42000 kJ/kg of fuel, mass flow of cooling in jacket = 456 kg/h, rise in temperature of cooling water 28 ℃, temperature of exhaust gas entering in calorimeter = 320 ℃, temperature of exhaust gas leaving from calorimeter = 220℃, rise in temperature in calorimeter water = 8℃, flow rate cooling water in calorimeter is 8 kg/min. Calculate indicated power, brake power, mechanical efficiency and brake thermal efficiency. Also draw up heat balance sheet.

b. Explain the working procedure of the Orsat apparatus for flue gases determination with suitable sketch. Also determine the air fuel ratio of C_3H_8 with 150 percent theoretical air supplied.

c. Explain the principle of working of steam impulse turbine. Why are steam turbines compounded? Explain the pressure-velocity compounding with neat diagram.

d. Calculate the mass of the flue gases flowing through chimney when the drought produced is equals to 1.9 cm of water. Temperature of the flue gas is 290℃ and the ambient temperature is 20℃. The flue gas formed per kg of fuel burnt are 23 kg. Neglect the losses and take the diameter of the chimney as 1.8 m.

e. Define the Steam Nozzle. Also derive the expressions for **velocity** of steam and **discharge** through steam nozzle.

SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a) Derive an expressions of efficiencies of Carnot cycle and Brayton cycle with suitable assumptions.

(b) In an air standard diesel cycle with compression ratio 14, the conditions of air at the start of compression stroke are 1 bar 300K. After addition of heat at constant pressure, the temperature rises to 2775K. Determine the thermal efficiency of the cycle, net work done per kg of air and the mean effective pressure. (take: R= 287 J/kg K and γ=1.4)

4. Attempt any *one* part of the following: 7 x 1 = 7

(a) A boiler which was originally designed to use coal as the fuel is converted into oil fired boiler. The details are: Equivalent evaporation from and at 100 ^{0}C using coal = 8.5 kg/kg of coal, Equivalent evaporation from and at 100 ^{0}C using oil = 14.5 kg/kg of oil, C.V. of oil = 42000 kJ/kg. Assuming thermal efficiency of the boiler to be same before and after conversion, find (i) Calorific Value of coal, (ii) Thermal efficiency of the boiler, (iii) Mass of oil consumed equivalent to 1000 kg of coal burnt.

(b) A simple Rankine cycle works between pressures 28 bar and 0.06 bar, the initial condition of steam being dry saturated. Calculate the dryness fraction, cycle efficiency, work ratio and specific steam consumption.

5. Attempt any *one* part of the following: 7 x 1 = 7

(a) Define the blade efficiency. Derive an expression for maximum blade efficiency for an impulse turbine. $(\eta_{blade})_{max} = Cos^2\alpha$

(b) In an impulse turbine the steam issues from the nozzle with a velocity of 1200

m/s. Nozzle angle is 20° and mean blade velocity is 400 m/s. The blades are equiangular. The mass flow rate is 1000 kg/min and friction factor is 0.8. Determine: (i) Blade angles, (ii) Axial thrust, (iii) Power, (iv) Blade efficiency, (v) Stage efficiency if nozzle efficiency is 93%.

6. Attempt any *one* part of the following: 7 x 1 = 7

(a) What are the essentials of a good boiler? Distinguish between Fire tube & Water tube boilers. Give two names of each. Give a neat-labeled sketch of a Babcox and wilcox Boiler.

(b) Condenser vacuum of a surface condenser is 70 cm of Hg, barometric reading is 76.5 cm of Hg, Mean condenser temperature = 35 $^{\circ}$C, hot well temperature = 28 $^{\circ}$C, condensate collected = 1800 kg/hr, cooling water inlet temperature = 12 $^{\circ}$C, cooling water outlet temperature = 27 $^{\circ}$C. Calculate: (i) vacuum efficiency, (ii) condenser efficiency.

7. Attempt any *one* part of the following: 7 x 1 = 7

(a) A gas turbine plants consists of two stage compressor with perfect intercooler and a single stage turbine. If the plants work between the temperatures limits 300 K and 1000 K and 1 bar and 16 bar. Find the net power of the plant per kg of air. Take specific heat at constant pressure 1 kJ/kgK.

(b) What is the principle of jet propulsion? Classify the jet propulsion engines. Explain the working of turbo jet engines by making neat sketch.