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(Following Paper ID and Roll No. to be filled in your Answer Books)

Paper ID : 140408

B.TECH.

Theory Examination (Semester-IV) 2015-16

APPLIED THERMODYNAMICS

Time : 3 Hours *Max. Marks : 100*

Section-A

Q1. Attempt all parts. All parts carry equal marks. Write answer of each part in short. (2×10=20)

(a) Define the heat rate using in the Rankine cycle.

(b) Define propulsive power and propulsive efficiency.

(c) Explain about congeneration.

(d) Explain the significance of Willian's law in steam engines.

(e) How Equivalent evaporation is used for comparison of boilers?

(f) What do you mean by a perfect cooling?

(g) Why Rankine cycle is modified?

(h) What is clausius clapeyron equation?

(i) Define adiabatic flame temperature.

(j) What do you mean by Thrust Augmentation?

Section-B

Q2. Attempt any five question. Each question carries equal marks. (5×10=50)

(a) What do you understand by inversion curve? Define Joules coefficient. How these can be used for refrigeration?

(b) A sample fuel has the following percentage composition by weight, Carbon = 84% hydrogen = 10%. oxygen = 3.5% nitrogen = 1.5% and Ash = 1%.

(i) Determine the stoichiometric air fuel ratio by mass.

(ii) If 20% excess air is supplied, find percentage composition of dry fuel gas by volume.

(c) What is the function of condenser? Classify and Explain Barometric jet condenser with neat sketch?

(d) A steam power plant operates on the regenerative cycle. Steam form boiler at 30 bar and 400°C is expanded in a turbine. A part of the steam is bled at 2 bar pressure in to the feed water heater and the remainder is condensed at 0.07 bar. Neglecting pump work, determine the work done per kg of steam and the efficiency of the cycle.

(e) A double acting single cylinder steam engine runs at 250 rpm and evelops 30 kW. The pressure limits of operation are 10 bar and 1 bar. Cut off is 40% of the stroke. The L/D ratio is 1.25 and diagram factor is 0.75. Assume dry saturated steam at inlet, hyperbolic expansion and neglighble effect of piston rod. Find:

(i) Mean effective pressure

(ii) Cylinder dimensions

(ii) Indicated thermal

(f) An impulse steam turbine of 180 kW has steam flowing at rate of 165 kg/min and leaving axially. Steam turbine blade speed is 175 m/s and it leaves nozzle at 400 m/s. For the blade velocity coefficient of 0.9.

Find nozzle angle, blade angles at inlet and exit, axial thrust and diagram efficiency.

(g) Define critical pressure ratio for nozzle of the steam turbine. Obtain analytically its value in terms of the index of expansion.

(h) With the help of Enthalpy-entropy and schematic diagrams explain the difference between the working of a propeller turbine and a jet turbine.

Section-C

Attempt any two question. Each question carries equal marks. **(2×15=30)**

Q3. The following data refer to a single stage impulse turbine: Isentropic nozzle heat drop = 251 kJ/kg : nozzle efficiency = 90% : nozzle angle = 20° : ratio of blade speed to whirl component of steam speed = 0.5 : blade velocity co-efficient = 0.9 ; the velocity of steam entering the nozzle = 20m/s. Determine:

(i) The blade angles at inlet and outlet if the steam enters in to the blades without shock and leaves the blades in an axial direction.

(ii) Blade efficiency

(iii) Power developed and axial thrust in an axial direction

Q4. (a) Why are the back work ratios relatively high in gas turbine plants compared to those of steam power plants?

(b) In a gas turbine plant compression is carried out in two stages with perfect intercooling and expansion in one stae turbine. If the maximum temperature (T_{max}, K) and minmum temperature (T_{min}, K) in the cycle remain constand, show that for maximum specific output of the plant, the optimum overall pressure ratio is given by

$$ro_{pt} = (\eta_T \cdot \eta_C \cdot T_{max}/T_{min})^{2\gamma/3(\gamma-1)}$$

Where γ – Adiabatic index : η_T = Isentropic efficiency of the turbine.

η_C = Isentropic efficiency of compressor.

Q5. A boiler generate 7.5 kg of steam per kg of coal burnt at a pressure of 11 bar, from feed water having a temperature of 70°C. The efficiency of boiler is 75% and factor of evaporation 1.15. specific heat of steam at constant pressure is 2.3. Calculate:

(i) Degree of superheat and temperature of steam generated;

(ii) Calorific value of coal in kJ/kg;

(iii) Equivalent evaporation in kg of steam per kg of coal.