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EME401

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

PAPER ID : 3989

Roll No. | | | | | | | | | | |

B.Tech.

(SEMESTER-IV) THEORY EXAMINATION, 2012-13

APPLIED THERMODYNAMICS

Time : 3 Hours]

[Total Marks : 100

SECTION – A

1. Attempt **all** question parts : **10 × 2 = 20**

   (a) Prove that specific heat at constant volume (c_v) of a Vander Wall's Gas is a function of temperature alone.

   (b) Define adiabatic flame temperature with example.

   (c) What are the various types of safety valves used in a boiler ?

   (d) State the comparison between Jet and Surface condenser.

   (e) Draw indicator diagram with and without clearance in steam engine.

   (f) What are the effects of friction on the flow through a steam nozzle ?

   (g) State the comparison between Rankine and Carnot cycle.

   (h) What is the function of governors in steam turbines ?

   (i) What is the basic difference between Rocket and Jet propulsion ?

   (j) Define propeller efficiency.

SECTION – B

2. Attempt any **three** question parts. **10 × 3 = 30**

   (a) Derive the following :

      (i) Expression for Joule – Thompson Co-efficient

      (ii) Maxwell relations (any two)

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(b) A boiler generates 7.5 kg of steam per kg of coal burnt at a pressure of 11 bar form of 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

(c) Superheated steam at a pressure of 10 bar and 400 °C is supplied to a steam engine. Adiabatic expansion takes place to a release point at 0.9 bar and it exhausts into a condenser at 0.3 bar. Neglecting clearance, determine for a flow rate of 1.5 kg/s :

(i) Quality of steam at the end of expansion and the end of constant volume operation.

(ii) Power developed.

(iii) Specific steam consumption.

(iv) Modified Rankine cycle efficiency.

(d) Explain clearly what you mean by saturation curve and missing quantity. Suggest the ways by which missing quantity is reduced.

(e) With the aid of the schematic diagram and thermodynamic process, explain the working of a turbo propeller engine.

SECTION – C

Attempt **all** questions : **10 × 5 = 50**

3. Attempt any **two** parts. **5 × 2 = 10**

(a) With a neat sketch, explain the working of Evaporative condenser.

(b) Define and explain Equivalent Evaporation.

(c) What is steam trap ? Sketch expansion type of steam trap with parts.

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4. Attempt any **one** part. **10 × 1 = 10**

(a) Derive the equation for Clausius Clapeyron Equation for evaporation of liquids.

(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 stoichometric air fuel ratio by mass

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

5. Attempt any **one** part. **10 × 1 = 10**

(a) A double acting single cylinder steam engine runs at 250 rpm and develops 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 negligible effect of piston rod.

Find :

(i) Mean effective pressure

(ii) Cylinder dimension

(iii) Indicated thermal efficiency

(b) Steam at a pressure of 15 bar and dryness fraction 0.97 is discharged through a convergent divergent nozzle to a back pressure of 0.2 bar. The mass flow rate is 9 kg/kW-hr, if the power developed is 220 kW. Determine the throat pressure and number of nozzles required if each nozzle has a throat of rectangular cross section of 4 mm × 8 mm. If 12% of overall isentropic enthalpy drop occurs in the divergent portion due to friction, find the cross section of the exit rectangular.

6. Attempt any **one** part : **10 × 1 = 10**

(a) Steam at 20 bar, 360 °C is expanded in a steam turbine to 0.08 bar. It then enters a condenser, where it is condensed to saturated liquid water. The pump feeds back the water into the boiler.

(i) Assuming ideal process, find per kg of steam the net work and the cycle efficiency.

(ii) If the turbine and the pump have each 80% efficiency, find the percentage reduction in the net work and cycle efficiency.

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(b) In a stage of impulse reaction turbine, steam enters with a speed of 245 m/sec, at an angle of 30° in the direction of blade motion. The mean speed of the blade is 145 m/sec, when the rotor is running at 300 r.p.m. The blade height is 10 cm. The specific volume of steam at nozzle outlet and blade outlet are 3.45 m^3/kg and 3.95 m^3/kg respectively. The turbine develops 287 kW of power. Assuming the efficiency of nozzle and blades combined considered is 90% and coefficient of discharge 0.8 ; Find :

(i) The enthalpy drop in each stage

(ii) Degree of reaction

(iii) Stage efficiency

7. Attempt any **two** parts. **5 × 2 = 10**

(a) A turbojet power plant uses aviation kerosene having calorific value of 43 MJ/kg. The fuel consumption is 0.18 kg per hr per thrust, when thrust is 9 kN. The aircraft velocity is 500 m/s the mass of air passing through the compressor is 27 kg/s. Calculate the air fuel ratio and overall efficiency.

(b) What are the two types of cycle arrangement possible for a gas turbine and what is the basic difference between the two arrangements ?

(c) State the assumptions made in actual and ideal cycle analysis of a gas turbine.