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

PAPER ID : 140407 Roll No. | | | | | | | | | | |

B.Tech.

(SEM. IV) THEORY EXAMINATION 2013-14

APPLIED THERMODYNAMICS AND MACHINE DRAWING–II

Time : 3 Hours *Total Marks : 100*

Note :– (1) Attempt **all** the questions.

(2) All questions should be attempted as directed in each Section.

(3) Be precise in your answer.

(4) Use of Steam table and Mollier chart is permitted.

(5) Assume relevant data if missing.

SECTION–I

1. Attempt **all** the parts : **(10×2=20)**

(a) Write the significance of Clausius-Clapeyron's equation.

(b) Define the term Adiabatic Flame temperature.

(c) What do you mean by 'Factor of Evaporation' and 'Boiler Efficiency' ?

(d) Define 'vaccum efficiency' and 'condenser efficiency'.

(e) Differentiate between Rankine cycle and Modified Rankine cycle.

(f) What to you mean by metastable flow in nozzle ?

(g) What are the characteristics of an ideal working fluid in vapour power cycle ?

(h) Why is partial admission of steam adapted for H.P. impulse stage while full admission is essential for any stage of a reaction turbine ?

(i) What do you mean by 'cycle air rate' and 'cycle work ratio' in gas turbine ?

(j) What is propulsive power and take-off thrust ?

SECTION–II

2. Attempt any **three** parts : **(10×3=30)**

(a) Starting from First Maxwell relation $\left(\frac{\delta T}{\delta V}\right)_S = -\left(\frac{\delta P}{\delta S}\right)_V$ and using cyclic relation, derive the remaining three Maxwell relations.

(b) Compare Fire tube boiler and Water tube boiler. Give the name of various mountings and accessories and explain any one from each with heat sketch.

(c) Derive an expression for mean effective pressure of a steam engine, considering the effect of clearance and compression. What do you mean by missing quantity ? How can it be minimized ?

(d) What do you mean by compounding of steam turbine ? Discuss various methods of compounding steam turbine.

(e) What is work ratio of a GT Plant ? Show that :

$$r_w = 1 - \left(\frac{T_1}{T_3}\right) r_p^{\frac{\nu - 1}{\nu}}.$$

SECTION–III

Note :– Attempt **all** the questions : **(10×5=50)**

3. Attempt any **one** part : **(10×1=10)**

(a) An ice skater is able to glide over the ice because the skate blade exerts sufficient pressure on the ice that a thin layer of ice is melted. The skate blade then glides over this thin lubricating layer. Determine the pressure exerted on ice skate blade to allow smooth ice skating at –10°C. Use $h_{fg} = 3.34 \times 10^5$ J/kg. Specific volume of water = 1×10^{-3} m³/kg. Specific volume of ice = 1.01×10^{-3} m³/kg. What will happen if the temperature goes below –15°C.

(b) What do you understand by heat of reaction and heat of formation ? The volumetric composition of dry products of combustion of an unknown hydrocarbon C_AH_B gives CO_2 12.1%, O_2 3.8%, CO 0.9% and N_2 83.2%. Determine :

(i) Chemical composition of fuel

(ii) A/F Ratio

(iii) Percentage of excess air used.

4. Attempt any **one** part : **(10×1=10)**

(a) A boiler is capable of generating 8 kg of steam per kg of fuel at 673 K. Feed water is supplied at a pressure of 30 bar, 313 K and leaves economizer at 423 K for entering to evaporator. Steam leaves evaporator with dryness fraction of 0.98 and enters the superheater. Fuel used has a calorific value of 29000 kJ/kg. Considering no pressure loss inside the boiler. Determine boiler efficiency and fraction of heat given to steam in each section of boiler.

(b) Prove that the maximum discharge in a draught (considering water column) is given by $176.5\frac{H}{T_a}$.

5. Attempt any **one** part : **(10×1=10)**

(a) Differentiate between actual and hypothetical indicator diagram. Also Plot P-V curve for both showing all the points. Dry and saturated steam at a pressure 12 bar is supplied to double acting steam engine cylinder. The cut-off occurs at 40% of stroke, the exhaust pressure is 1.2 bar. The clearance is 10% of stroke. Find mean effective pressure if the break power is 80%, mean piston speed is 70 m/min. Find the cylinder diameter.

(b) If 10 kg/sec air at 9 bar, 250°C expands through the nozzle in a space at 1.2 bar, find the diameter at the throat and exit of the nozzle. Neglect approximate velocity.

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

(a) Write short notes on following with neat sketch :

(i) Cogeneration

(ii) Combined Gas turbine with vapour power cycle

(iii) Rankine cycle with Reheat.

(iv) Binary Vapour Cycle.

(b) The velocity of steam exiting the nozzle of the impulse stage of a turbine is 400 m/sec. The blades operate close to the maximum blading efficiency. The nozzle angle is 20° considering equiangular blade and neglecting blade friction. Calculate for a steam flow of 0.6 kg/sec., the diagram power and diagram efficiency.

7. Attempt any **one** part : **(10×1=10)**

(a) In a gas turbine plant air enters the L.P. compressor having a pressure ratio of 3.5 and efficiency 0.85 at 1 bar and 300 K. It then enters the intercooler where it is cooled down to 310 K. The cooled air is further compressed in H.P. compressor also having a pressure ratio of 3.5 and efficiency of 0.35. It enters the regenerator having an effectiveness of 0.8. The gases coming out of combustion the H.P. turbine of efficiency 0.88 at 1100 K. The H.P. turbine derives the compressor and there is a reheat between the two turbines. The gases enter the L.P. turbine at 1050 K and exhaust gas coming out of L.P. turbine of efficiency 0.88 are used to heat the air in the regenerator before leaving to the atmosphere. Determine (i) Power output (ii) Overall efficiency of plant. Take C_p for air as 1.005 and for gases as 1.15 kJ/kg K and ν for air 1.4 and for gas 1.3.

(b) With the help of h-s and schematic diagrams explain the difference between the working of a propeller turbine and jet turbine. Derive expression for specific thrust, thermal efficiency and propulsive efficiency for a jet plane.