Prelim Paper **17410**

3 Hours / 100 Marks **Thermal Engineering**

Instructions : (1) All Questions are Compulsory.
(2) Answer each next main Question on a new page.
(3) Illustrate your answers with neat sketches wherever necessary.
(4) Figures to the right indicate full marks.
(5) Assume suitable data, if necessary.
(6) Use of Non-programmable Electronic Pocket Calculator is permissible.
(7) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.
(8) Use of Steam tables, logarithmic, Mollier's chart is permitted.

1. (a) Attempt any **SIX** of the following : **[12]**

(i) State first law of thermodynamics.
(ii) Define thermodynamics work. Write its SI unit.
(iii) Write Charles Law as applied to an Ideal gas.
(iv) Represent Isothermal Process for an Ideal Gas on P – Vand T – S chart.
(v) Define :
(1) Degree of superheat
(2) Latent Heat for steam
(vi) Explain what is bleeding of a steam.
(vii) Define Mach Number and state the significance of the same.
(viii) Write the sources of air leakage in steam condenser.

(b) Attempt any **TWO** of the following : **[8]**

(i) List six boiler mountings. Sketch any one boiler mounting and label the same.
(ii) Define Daltons law of partial pressure and give its application.
(iii) Explain working of Shell and Tube type of Heat Exchanger with a neat sketch.

2. Attempt any **FOUR** of the following : **[16]**

(a) Write general Steady Flow Energy Equation (SFEE) per unit mass. Apply this equation to a
(i) Nozzle (ii) Steam condenser

(b) 0.340 m^3 of gas at 8 bar and 130°C is expanded adiabatically until its pressure is 5 bar. It is then compressed isothermally to its original volume. Calculate
(i) Final temperature (ii) Final pressure
of gas. Take $C_p = 0.950$ kJ/kg K
$C_v = 0.710$ kJ/kg K

(c) Give classification of steam boilers on the basis of
(i) according to use (ii) location of furnace
(iii) axis of shell (iv) fuel used

(d) Differentiate between impulse steam turbine and reaction type steam turbine (minimum six points)
(e) Describe throttle governing of steam turbines.
(f) Define :
(i) Zeroth law of thermodynamics (ii) Law of conservation of energy.

3. Attempt any **FOUR** of the following : **[16]**
(a) Explain :
(i) Point function (ii) Path function
(iii) State (v) Process
(b) Write equation for
(i) change in internal energy (ii) work done
for a reversible adiabatic process.
(c) Explain the principle used in forced draught and induced draught in a boiler. Also, state advantages of artificial draught over natural draught.
(d) Explain the necessity of compounding of steam turbines. Also, state various types of compounding in steam turbines.
(e) Explain the function of cooling tower in steam power plant. List various types of cooling towers.
(f) (i) Define thermal conductivity. State its unit.
(ii) State Fouriers law of heat conduction.

4. Attempt any **FOUR** of the following : **[16]**
(a) Define point function and path function with two examples of each.
(b) What is boiler draught? State its necessity.
(c) Explain working of impulse steam turbine by using pressure velocity variation diagram.
(d) Determine the rate of heat flow through the boiler wall made of 3 cm thick steel and covered with an insulating material of 0.5 cm thick. The temperature of wall inside boiler is 300°C and temperature of outer surface is 50°C.
Assume K for steel = 60 W/mK
K for insulation = 0.12 W/mK
(e) The vacuum in a surface condenser is 705 mm of Hg and the barometer reading is 760 mm of Hg. The outlet and inlet temperature of cooling water to condenser is 37.5°C and 30°C respectively. Determine condenser efficiency.
(f) Determine the state of steam if :
(i) Pressure is 10 bar and specific volume is 0.185 m^3/kg.
(ii) Pressure is 12 bar and temperature is 200°C.

5. Attempt any **TWO** of the following : **[16]**
(a) Explain the application of second law of thermodynamics to heat engine.
(b) What is governing of steam turbine? Explain with neat sketch nozzle control governing.

(c) 1 kg of air at a pressure of 14 bar occupies 0.6 m^3 and from this condition it expands to 1.4 bar according to law $PV^{1.25} = C$. Find :
(i) Change in internal energy (ii) Work done by air
Assume $C_p = 1.005$ KJ/kg K and $C_v = 0.718$ KJ/kg K

6. Attempt any **TWO** of the following : **[16]**

(a) Explain construction and working of surface condenser with neat sketch.

(b) Explain the construction and working of Babcock and Wilcox boiler with neat labelled sketch.

(c) A steam pipe of 16 cm inside diameter and 17 cm outside diameter (K = 58 W/mk) is covered with first layer of insulating material of 3 cm thick (K = 0.17 W/mk) and second layer of insulating material 5 cm thick (K = 0.093 W/mk). The temperature of steam passing through the pipe is 300°C and atmosphere is 30°C.
Take $h_i = 30$ W/m^2K
$h_o = 5.8$ W/m^2K
Find the heat lost per metre length of pipe.

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