17410

11920

3 Hours / 100 Marks Seat No. | | | | | | | | |

Instructions – (1) All Questions are *Compulsory.*

(2) Illustrate your answers with neat sketches wherever necessary.

(3) Figures to the right indicate full marks.

(4) Use of Non-programmable Electronic Pocket Calculator is permissible.

(5) Mobile Phone, Pager and any other Electronic Communication devices are not permissible in Examination Hall.

(6) Use of Steam tables, logarithmic, Mollier's chart is permitted.

Marks

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

(i) In a boiler enthalpy of water supplied was 2000 kJ/kg. Enthalpy being added by fuel combustion is 3200 kJ/kg. Using first law of thermodynamics, find amount of heat supplied if steam generation rate is 10 tons per hour.

(ii) Find molar volume of air when volume of a container in which air is contained is $3\,m^3$ where as mass of air is 3.81 kg. Take molecular weight of air 29.

(iii) Steam is available at turbine inlet at 10 bars and 250°C. Locate point on T-S diagram. Find degree of superheat.

(iv) Comment on Mach number of steam in impulse and reaction turbines.

(v) State two factors on which efficiency of cooling tower depends.

Marks

(vi) Identify modes of heat transfer involved in following applications with brief explanation.
(1) Radiator of automobile
(2) Condenser of domestic refrigerator.

(vii) Categorize point and path functions from following. (pressure, heat, internal energy, temperature, work, total enthalpy.)

(viii) A gas is compressed from 1 bar and 30°C to 5 bars and 30°C. Identify process and show on PV diagram.

b) **Attempt any <u>TWO</u> of the following:** **8**

(i) Describe thermodynamic equilibrium with two suitable examples.

(ii) Use equation of state to find density of air when atmospheric conditions are 760 mm of Hg and 30 °C.
Take R = 287 J/kg K.

(iii) Represent generation of steam on H-S diagram. Show constant dryness fraction lines, constant temperature lines, saturated line and superheated region on the same.

2. Attempt any <u>FOUR</u> of the following: **16**

a) Write continuity equation for nozzles. State meaning of all terms involved with their units.

b) In surface condensers write role of
(i) Water tubes
(ii) Shell
(iii) Baffle plate
(iv) Tube sheet

c) A typical application has wall made up of two different materials with inner layer 20 mm thick and outer layer 3 mm thick. The temperature difference across wall is 35°C. Thermal conductivity of inner layer material is 0.1 W/m K and outer layer material is 20 W/m K. How much heat will transfer per m^2 of the wall will take place across the wall.

Marks

d) State two similarities and two dissimilarities between heat and work.

e) Differentiate between isothermal and isentropic processes (any four points)

f) In a constant pressure process steam is generated from 10 bar and 0.8 dry condition till it become dry and saturated. Determine amount of heat added per kg of steam. From steam table at 10 bar T_{sat} = 179.9°C h_f = 762.6 kJ/kg, hg = 2776.2 kJ/kg

3. Attempt any <u>FOUR</u> of the following **16**

a) With neat sketch describe working of reaction turbine.

b) Find condenser efficiency when following readings were obtained on a steam surface condenser.
(i) Atmospheric pressure = 760 mm of Hg
(ii) Vacuum in condenser = 690 mm of Hg
(iii) Cooling water inlet temperature = 28°C
(iv) Cooling water outlet temperature = 39°C

c) State Fourier's law of conduction and Stefan Boltzmann law of radiation. Express mathematically.

d) State first law of thermodynamics for
(i) closed system and cyclic process
(ii) closed system and non-cyclic process

e) Air is heated at constant volume from initial condition of 1 bar and 30°C to 5 bar.

Calculate
(i) Final Temperature
(ii) Work done
(iii) Change in Enthalpy.
Take for air R = 287 J/kg K, Cp = 1.005 kJ/kg K

f) State regulations for boilers which fall under IBR boilers. (Any four)

Marks

4. Attempt any FOUR of the following: 16

a) Draw a neat sketch of regenerative feed heating.

b) Describe with neat sketch working of natural draft cooling towers.

c) Describe only construction and working of pipe in pipe heat exchanger. State it's two applications.

d) Compare performance of refrigerator and heat pump when both are operating between 9°C and 35°C. Assume both are working on reversible carnot cycle.

e) Describe any one safety mounting used in boilers with sketch.

f) Describe four losses in steam turbines in ½ sentences each.

5. Attempt any FOUR of the following: 16

a) Describe any two sources of air leak in surface condenser. Also describe effect of air leak on latent heat of steam and cooling water requirements.

b) Differentiate induced draft and forced draft cooling towers based on
   (i) Location of fan
   (ii) Corrosion of blades
   (iii) Efficiency
   (iv) Fan size

c) A typical shape when perfect black emits 150 W/m^2 energy by radiation. How much energy will it radiate when it is not perfectly black and have emissivity of 0.8.

d) An engine is supplied with 4 kW of heat energy. It is found that it produce 4 kW of work. Which kind of perpetual machine it is? Which law is violated? Also describe other kind of perpetual machine you know.

e) Write steady flow energy equation considering mass flow rate of fluid. Write units of different quantities involved.

f) An ideal gas is heated at constant volume and then expanded isothermally. Show processes on PV & TS diagrams.

Marks

6. Attempt any FOUR of the following: **16**

a) Represent constant volume process on PV & TS diagram for steam.

b) Draw Lamont Boiler. Label the components and discuss the working and construction.

c) State necessity of super heater in steam boilers. State advantages of economizer. (two each)

d) Describe velocity compounding with neat sketch.

e) Explain Dalton's law in respect to steam condensers.

f) Define heat exchanger. Classify heat exchangers based on geometry, direction of fluids, method of heat exchange.