2007

MECHANICAL ENGINEERING - II (OPTIONAL)   100020

Standard : Degree

Total Marks : 200

Nature : Conventional

Duration : 3 Hours

Note :

(i) Answers must be written in **English**.

(ii) Question **No. 1** is **Compulsory.** Of the remaining questions, attempt **any four** selecting one question from **each section.**

(iii) Figures to the **RIGHT** indicate marks of the respective question.

(iv) Use of log table, Non-Programmable calculator is permitted, but any other Table/Code/Reference book are not permitted.

(v) Make suitable assumptions, wherever be necessary and state the same.

(vi) Number of optional questions upto the prescribed number in the order in which they have been solved will only be assessed. Excess answers will not be assessed.

(vii) Credit will be given for orderly, concise and effective writing.

(viii) Candidate should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise he/she will be penalised.

1. *Answer any four of the following :*

   (a) With suitable example define and explain the terms : work output, efficiency, mean effective pressure, indicated power and brake power.   **10**

   (b) (i) What do you think of strategies required for long term management of energy in India ?   **5**

   (ii) Define "Energy Audit" as mentioned in the Energy conservation act 2001.   **2**

   (iii) A hospital requires 10,000 liters of water at 65°C daily. Which type of solar collector system will you choose. Justify your answer.   **3**

   (c) Explain the working of a centrifugal compressor with a neat sketch. What is surging effect ? Give remedies to avoid surging.   **10**

P.T.O.

Marks

(d) (i) List the various types of temperature transducers. Explain in brief principle and working of thermocouple transducer.   **6**

    (ii) Explain in brief with suitable example.   **4**
      (1) Accuracy
      (2) Precision

(e) (i) What are the flaws of steam as the working fluid ?   **5**
    (ii) What is the function of a steam trap ?   **2**
    (iii) What is heat rate ? What does it indicate ?   **3**

SECTION - A

2. Answer the following sub-questions :

(a) (i) State S I units for energy, power, enthalpy, entropy and refrigerating capacity.   **5**

    (ii) With the help of neat sketch write the steady flow energy equation (SFEE) which is a form of first law of thermodynamics and then reduce it to define rise in enthalpy for an ideal gas when changes in kinetic and potential energy are negligible and no external work is done.   **5**

(b) Draw the T-S diagram for Steam Power Plant and explain various processes. State the equations for work output, heat supplied and efficiency of the system.   **10**

(c) Three 10 mm diameter rods A, B and C protrude from a steam bath at 100°C to a length of 25 cm into the atmosphere at 20°C. The temperatures at the other ends are found to be 26.76°C for A, 32.00°C for B and 36.93°C for C. Neglecting the effects of radiation and assuming the surface film coefficient of heat transfer as 23 W/m²K, evaluate their thermal conductivities.   **10**

(d) (i) Differentiate between 'Black Body' and 'Gray Body' in radiation heat transfer. Define a geometrical or shape factor in radiation.   **5**

    (ii) Explain various modes of mass transfer. State Fick's law of diffusion.   **5**

3. (a) (i) Differentiate between :   **5**
      (1) Thermal, Mechanical and Chemical equilibrium
      (2) Intensive and Extensive Properties
      (3) Point function and Path functions

    (ii) Air initially at 3.5 bar and 15°C is enclosed in a vessel 0.06 m³ in volume. It is allowed to expand in an evacuated vessel also 0.06 m³ in volume. If the process is adiabatic, find the change in entropy of the air.   **5**

Marks

(b) A steam power plant with inlet steam to the h.p. turbine at 90 bar and 500°C and **10** condensation at 40°C produces 500 MW. It has one stage of reheat optimally placed which raises the steam temperature back to 500°C. One closed feedwater heater with drains cascaded back to the condenser receives bled steam at the reheat pressure, and the remaining steam is reheated and then expanded in the l.p. turbine. The h.p. and l.p. turbines have isentropic efficiencies of 92% and 90% respectively. The isentropic efficiency of pump is 75%. Calculate (a) the mass flow rate of steam at turbine inlet in kg/s, (b) the cycle efficiency and (c) the cycle work ratio. Use TTD $= -1.6$°C.

(c) Explain critical radius of insulation. Calculate the critical radius of insulation for **10** asbestos (k $= 0.172$ W/mK) surrounding a pipe and exposed to room air at 300K with h $= 2.8$ W/m^{2}K. Calculate the heat loss from a 475 K, 60 mm diameter pipe when covered with the critical radius of insulation and without insulation.

(d) Define the terms emissive power, emissivity absorptivity, reflectivity and **10** transmissivity in radiation heat transfer. State Planks law and Wien's displacement law.

SECTION - B

4. Answer the following sub-questions :

(a) (i) A fluid has an absolute viscosity 0.048 Pa.s that flows over a flat solid surface. **3** The velocity at a point 75 mm away from the boundary surface is 1.125 m/ s. Calculate the shear stress at the solid boundary.

(ii) Two reservoirs 5.2 km apart are connected by a pipeline which consists of a **7** 225 mm diameter pipe for the first 1.6 km, sloping down at 5.7 m per km. For the remaining distance the pipe diameter is 150 mm laid at the slope of 1.9 m per km. The levels of water above the pipe openings are 6 m in the upper reservoir and 3.7 m in the lower reservoir. Taking friction factor $f = 0.024$ for both pipes and coefficient of contraction Cc $= 0.6$. Calculate the rate of discharge through the pipeline.

(b) A pelton wheel running at 480 rpm and operating under an available head of **10** 420 m is required to develop 4800 kW. There are two equal jets and the bucket deflection angle is 165°. The overall efficiency is 85% when the water is discharged from the wheel in a direction parallel to the axis of rotation. The coefficient of velocity of nozzle $= 0.97$ and the blade speed ratio 0.46. The relative velocity of water at exit from the bucket is 0.86 times the relative velocity at inlet. Calculate,

(i) Cross-sectional area of each jet.

(ii) Bucket pitch circle diameter.

(iii) Hydraulic efficiency of the turbine.

P.T.O.

			Marks

(c) (i) Explain functioning of a relief valve. **3**

(ii) Classify flow control valves and state their uses. **4**

(iii) What are the uses of accumulators and intensifiers in hydraulic systems. **3**

(d) (i) Explain the characteristic features of Pressurized Water Reactor (PWR). **5**

(ii) What are the factors considered while selecting a site for a hydroelectric plant ? **5**

5. Answer the following sub-questions :

(a) (i) Water flows through a 300 mm × 150 mm horizontal venturimeter at the rate of 37 liters per second and the differential mercury manometer shows a deflection of 20 mm. Determine the coefficient of discharge of the meter. **7**

(ii) Explain the difference between the Eulerian and Lagrengian approach of study in fluid mechanics. **3**

(b) (i) A centrifugal pump rotating at 1500 rpm delivers 0.2 m^3/s at a head of 15 m. Calculate the specific speed of the pump and the power input. Assume overall efficiency of the pump as 0.68. If this pump were to operate at 900 rpm. What would be the head discharge and power required for homologous conditions ? Assume overall efficiency remains unchanged at new rpm. **7**

(ii) How air compressors are classified. **3**

(c) What remedial actions will you suggest in case of the following faults in a typical hydraulic circuit. Explain probable causes also. **10**

(i) Excessive noise in pump

(ii) Noisy motor

(iii) Excessive heat in oil

(d) (i) What is doubling time in electricity production ? For a typical case, if rate of increase fraction is 6.2% what is the doubling time in years ? **5**

(ii) What are the two key parameters of water on which the magnitude of hydropower depends ? **3**

(iii) What is the importance of a surge tank in a hydro plant. **2**

Marks

SECTION - C

6.   Answer the following sub-questions :

(a)   Draw four-stroke S. I. engine cycle on P-v and T-s diagram. Derive the formula   **10**
      for air standard efficiency of S. I. engine in terms of compression ratio. State
      clearly the assumptions made.

(b)   (i)   State the various fuel ignition systems used in S. I. engines. Explain one of   **7**
            the fuel ignition system of an S. I. engine with the help of a block diagram.

      (ii) Explain the working of a power steering system of a passenger car with a   **8**
            neat sketch.

(c)   Represent simple vapor compression refrigeration cycle on P-v, T-s ; h-s ; and   **15**
      p-h diagrams.

            A vapour compression refrigeration system operates on R134a refrigerant
      at condensing temperature of 35°C and evaporating temperature of −10°C. The
      speed of the compressor is 2800 rpm. The ratio of clearance volume to swept
      volume is 0.03. The swept volume of the compressor is 270 cubic centimeter. The
      index of expansion = 1.12. You can assume compressor efficiency as 0.8. The
      sub-cooling effect in the condenser is 5°C. Specific heat for vapor = 1.1 kJ/kg°C.

      Find :

      (i)   Refrigeration effect in TR

      (ii)   Power of compressor in kW

      (iii) COP

      (iv)   Heat rejected in the condenser.

      You can use the following data

T°C	P bar	Vg m³/kg	hf kJ/kg	hg kJ/kg	Sf kJ/kg K	Sg kJ/kg K
-10	2.014	0.0994	186.7	392.4	0.9512	1.733
35	8.87	-	249.1	417.6	1.168	1.715

7.   Answer the following sub-questions :

(a)   Why a carburettor is needed for S. I. engine ? Explain the working of a solex-type   **10**
      carburettor with an illustrated diagram.

(b)   (i)   Explain any two types of transmission systems of an automobile.   **7**

      (ii) Illustrate the suspension system of a transportation truck.   **8**

P.T.O.

Marks

(c) (i) Define the following terms DPT, RH, Specific humidity, enthalpy of moist   5
air and sensible heat factor.

(ii) An air conditioning system operates to maintain dry bulb temperature at   10
25°C and RH 50%. The outside conditions are 40°C DBT and 27°C WBT.
Fifty percent of the room air is rejected to atmosphere and an equal quantity
of fresh air is added before air enters the air conditioning apparatus. If the
fresh air added is 100 cmm determine the following assuming a bypass
factor as zero density of air = 1.12 kg/m³ at a total pressure of 1.01325 bar.
Room sensible heat factor = 0.8. Draw the process diagram.

(1) Room sensible and latent heat loads.

(2) Sensible and latent heat loads due to fresh air.

(3) Apparatus due point

(4) Specific humidity and DBT of air eutering the AC apparatus.

SECTION - D

8. Answer the following sub-questions :

(a) (i) Differentiate between Line and End standard   4

(ii) Differentiate between hole basis system and shaft basis system.   4

(iii) "Development of microelectronics have progressed NC to CNC" Justify the   5
statement with appropriate illustration.

(iv) What are the application criteria for DNC systems ?   2

(b) A ball at 1200 K is allowed to cool down in air at an ambient temperature of   15
300 K. Assuming heat is lost only due to radiation, the differential equation for

the temp. of the ball is given by. $\dfrac{d\theta}{dt} = -2.2067 \times 10^{-12} \, (\theta^4 - 81 \times 10^8)$ where θ is

in K and t is in seconds. Find the temperature at t = 480 seconds using Runge
Kutta second order method. Assume a step size of h = 240 seconds. Also write
down its algorithm and draw the flowchart.

(c) Draw the block schematic of vision system and explain in detail.   10

9. Answer the following sub-questions :

(a) (i) Draw and explain in detail the measurement of gear tooth thickness by   8
gear tooth vernier calliper.

(ii) Explain the types of automatic tool changers.   7

(b)　(i)　Find the least squares line associated with the following data.　　　**10**

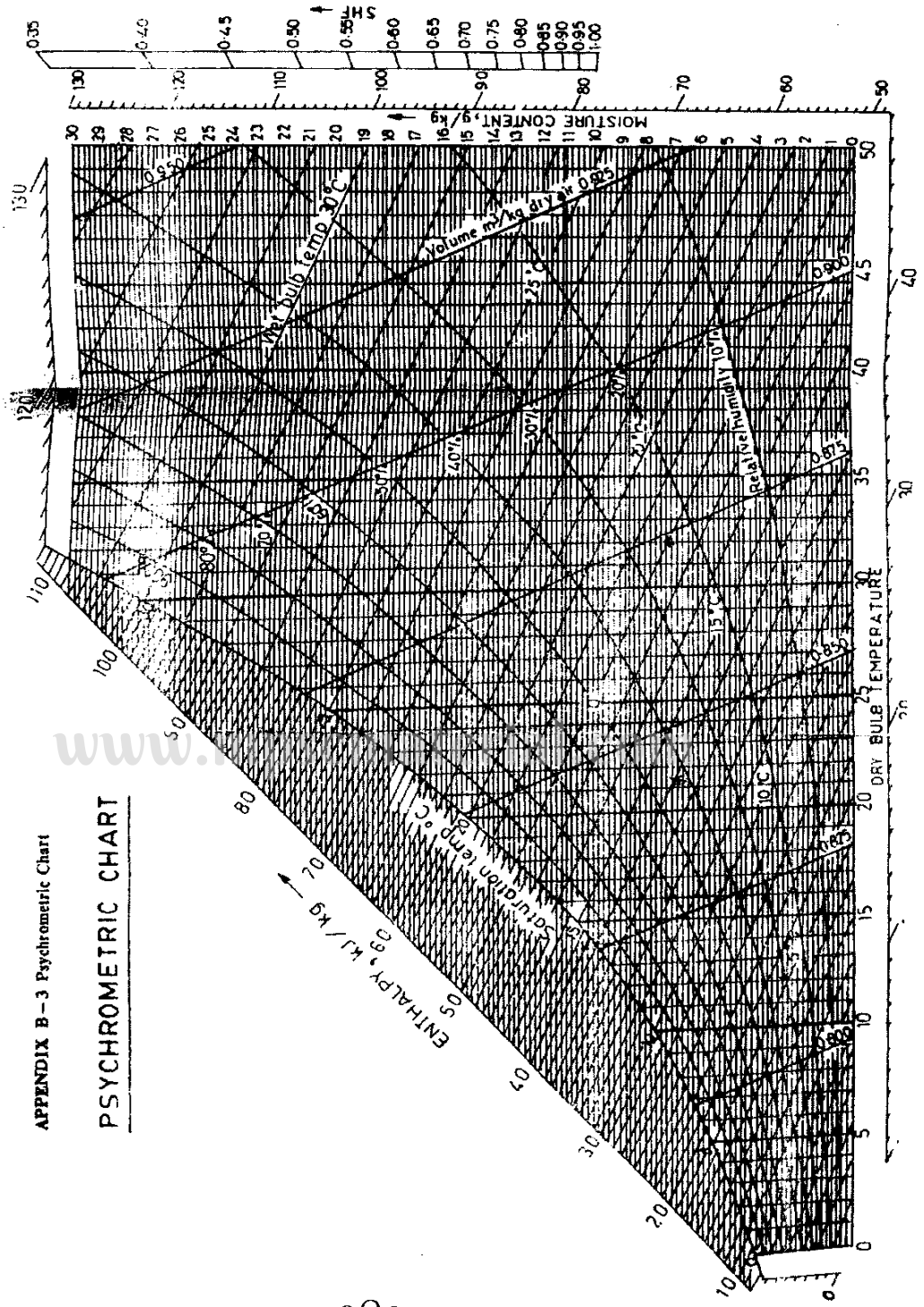| x	1	2	3	4
y	1.5	1.6	2.1	3.0

　　(ii)　Explain the following.　　　　　　　　　　　　　　　　　**5**

　　　　(1)　Round of errors

　　　　(2)　Truncation errors.

(c)　Write the controller output equations if P, I, D or PID actions are selected. Explain　**10**
in brief the importance of bias pcos in this equation. Draw the sketch of controller
response to step change if PI, PD or PID actions are selected.

APPENDIX B-3 Psychrometric Chart

PSYCHROMETRIC CHART

-oOo-