2009

MECHANICAL ENGINEERING - II (OPTIONAL)

100071

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) What is perfect gas ? State equations for governing laws, work done and heat supplied for constant volume, constant pressure and isothermal processes for perfect gas. **10**

(b) (i) Define the terms energy, exergy and anergy. **2**

(ii) What do you mean by 'Energy Management' ? **3**

(iii) Explain with neat sketch the construction, working of a Janata model gobar gas plant. **5**

(c) Explain with the help of block diagrams and temperature-entropy diagrams the methods to improve thermal efficiency of a simple open cycle constant pressure gas turbine plant. **10**

(d) (i) What is thermostat ? Explain in detail the principle and working of thermostat. State its one typical application and elaborate. **6**

(ii) Is it possible to measure displacement using ultrasonic transducer ? Justify with suitable example. **4**

(e) (i) What is Boiler efficiency ? **2**

(ii) Define load factor of a power plant and explain the effect of load factor on the cost of electricity generated. **3**

(iii) Compare hydro and thermal power plant. **5**

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SECTION - A

Marks

2. Answer the following sub-questions :

(a) What is thermodynamics ? Explain the terms system, boundary and surroundings with the help of suitable example. State first and second law of thermodynamics. **10**

(b) Draw the carnot cycle on T-S diagram. Explain the processes involved. Explain why it is ideal cycle along with its importance in Thermodynamics ? State the equations for work done, heat supplied and efficiency of the cycle. **10**

(c) What are various modes of heat transfer ? Explain the mechanism of how heat transfer takes place in these modes ? Write the basic equations required to calculate the rate of steady state one dimensional heat transfer for each mode and explain various terms used in these equations and their units. **10**

(d) Define Nusselt number, Prandtl number, Grashoff number, Reynolds number and Stanton number. **10**

Show that these numbers are dimensionless.

3. Answer the following sub-questions :

(a) (i) 100 kg of ice at $-5°C$ is placed in a bunker to cool some vegetables. 24 hours later the ice has melted into water at 10°C. What is the average rate of cooling in KJ/hour and TR provided by the ice ? **5**

Take: Specific heat of ice = 1.94 KJ/kg K.

Specific heat of water = 4.187 KJ/kg K.

Latent heat of fusion of ice at 0°C = 335KJ/kg.

(ii) Differentiate between Macroscopic and Microscopic Approach used in Thermodynamics. **5**

(b) Steam at 40 bar, 500°C flowing at the rate of 5500 kg/hour expands in a h.p. turbine to 2 bar with an isentropic efficiency of 83%. A continuous supply of steam at 2 bar 0.87 quality and a flow rate of 2700 kg/hour is available from a geothermal energy source. This steam is mixed adiabatically with the h.p. turbine exhaust steam and the combined flow then expands in a l.p. turbine to 0.1 bar with an isentropic efficiency of 78%. Determine the power output and the thermal efficiency of the plant. Assume that 5500kg/hour of steam is generated in the boiler at 40 bar, 500°C from the saturated feed water at 0.1 bar. **10**

Had the geothermal steam not been added, what would have been the power output and efficiency of the plant ? Neglect pump work. Use steam table.

Marks

(c) The temperatures on the two surfaces of a 25 mm thick steel plate, (K = 48W/m.k) having a uniform volumetric heat generation of $30 \times 10^6 W/m^3$, are 180°C and 120°C. Neglecting the end effects, determine the following : **10**

(i) The temperature distribution across the plate.

(ii) The value and position of the maximum temperature and

(iii) The flow of heat from each surface of the plate.

(d) In a certain double pipe heat exchanger hot water flows at a rate of 50000kg/hour and gets cooled from 95°Cto 65°C. At the same time 50000kg/hour of cooling water at 30°C enters the heat exchanger. The flow conditions are such that overall heat transfer coefficient remains constant at 2270 $W/m^2.K$. Determine the heat transfer area required and the effectiveness, assuming two streams are in parallel flow. Assume for the both the streams Cp = 4.2KJ/kgK. **10**

SECTION - B

4. Answer the following sub-questions :

(a) (i) Explain with neat sketch the relation between absolute pressure, gauge pressure, atmospheric pressure and vaccum pressure. **3**

(ii) A tank 2.5 meters high standing on the ground is kept full of water. There is an orifice in its vertical side at a depth '*h*' meter below the surface. Find the value of '*h*' in order that the jet may strike the ground at maximum distance from the tank. Also find this maximum distance if coefficient of velocity CV = 0.98. **7**

(b) (i) A pelton wheel operates under a head of 60m when running at 200 rpm. The pelton wheel develops 96 kW shaft power. The velocity of the buckets is 0.45 times the velocity of the jet. The overall efficiency and co-efficient of velocity are 0.85 and 0.98 respectively. **7**

Find :

(1) Diameter of Wheel (D)

(2) Overall discharge through nozzle (Q)

(3) Diameter of jet (d)

(4) Number of buckets on the wheel

(ii) What is the function of a draft tube in reaction turbines ? List different types of draft tubes. **3**

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(c) (i) Differentiate between hydraulic and pneumatic systems. 5

(ii) Explain with neat sketch the working and application of 'Meter-in-circuit' in hydraulic systems. 5

(d) (i) Classify the hydro turbines according to head, power, size and specific speed. 5

(ii) Explain the effect of variation of supply steam pressure, temperature and condenser pressure on thermal efficiency of steam power plant. 5

5. Answer the following sub-questions :

(a) (i) Define the following properties of a liquid : 4

(1) Cohesion (2) Adhesion (3) Surface tension

(ii) A jet plane having a wing area of 20 m^2 and weighing 25 kN flies at 950 Km/hr speed. The engine develops 8500 kW and has a mechanical efficiency of 60%. Determine the lift and drag coefficients of the wind. Take specific weight of air = 12N/m^3. 6

(b) (i) Draw and explain operating characterstic curves of a centrifugal pump. 3

(ii) Find the power required to drive a centrifugal pump which delivers 0.04 m^3/s of water to a height of 20m through a 15 cm diameter pipe and 100m long. The overall efficiency of pump is 70% and coefficient of friction is 0.15. 7

(c) (i) State the function of a 'FRL' Unit in pneumatic system. 2

(ii) Draw ISO symbols for following components for fluid circuits. 3

(1) non return flow control valve.

(2) 4/3 direction control valve.

(3) Sequence valve.

(iii) Classify the pumps used in hydraulic systems. Explain with neat sketch the construction and working of a swash plate axial piston pump. 5

(d) (i) What is Boiling Water Reactor (BWR) ? How it differ is from Pressurised Water Reactor (PWR) ? 5

(ii) What are the advantages and disadvantages of a diesel power plant ? 3

(iii) Explain the effect of regeneration in a gas turbine plant. 2

Marks

SECTION - C

6. Answer the following sub-questions :

(a) Represent two-stroke Diesel cycle on P-V and T-S diagram. Derive an equation for thermal efficiency of a Diesel cycle in terms of compression ratio (Rc) and cut-off ratio (ϱ). The mean effective pressure of a diesel cycle is 7.5 bar and the compression ratio is 12.5, find the percentage cut-off of the cycle if the initial pressure is 1 bar. **10**

(b) What are the steering system requirements ? State their functions. List the parameters which influence the close contact of tyres with the road surface. Explain with a neat sketch- Ackermann-Jeantaud steering linkage. **15**

(c) An ammonia plant works between the temperature limits of $-14°C$ evaporating temperature and 25°C condensing temperature. The ammonia refrigerant enters the condenser at 45°C and leaves at 15°C. The quantity of ice produced at $-5°C$ from water at 22°C is 360kg/hr. The vapour is compressed isentropically in the compressor. **15**

Determine :

(i) The condition of vapour at inlet to the compressor.

(ii) Refrigerating effect per kilogram.

(iii) Work to be done in KJ/kg.

(iv) Coefficient of performance.

(v) Mass flow rate of refrigerant.

(vi) Heat rejected in the condenser.

Explain the effect of wet compression on the compressor working. To solve above numerical example you can use the following properties.

Temp	Pressure	Enthalpy KJ/kg		Entropy, KJ/kgK	
in ° C	in Bar	hf	hg	Sf	Sg
25	11	316	1473	1.1774	5.002
15	11	255	1464	0.9722	5.1475
−14	2.5	118	1432	0.4765	5.5327

7. Answer the following sub-questions :

(a) (i) Explain the effect of following parameters knocking self ignition temperature of fuel, Air-fuel ratio, compression ratio, location of spark plug, Engine speed. **5**

(ii) Differentiate SI and CI engines on any five points. **5**

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(b) The following data is collected from a test conducted on a single cylinder four-stroke automobile engine. Cylinder bore = 150mm, engine stroke = 250 mm. Area of indicator diagram = 450mm^2, length of indicator diagram = 50mm indicator spring rating = 1.2mm, engine speed = 420 rpm, brake torque = 217 Nm, fuel consumption = 2.95 kg/hr, calorific value of fuel = 44000 KJ/kg, Flow rate of cooling water = 4kg/min, Rise of temperature of cooling water = 45°C, Specific heat of water = 4.186 KJ/kg°C. 15

Calculate :

(i) Mean effective pressure, N/m^2.

(ii) Indicated power in kW.

(iii) Brake power in kW.

(iv) Brake thermal efficiency.

(v) Specific fuel consumption.

(vi) Make Heat balance sheet.

(c) Draw a neat sketch of a Psychrometric chart. Label the various curves on such a chart. Explain with suitable example the construction of constant relative humidity lines and saturation lines. 15

SECTION - D

8. Answer the following sub-questions :

(a) (i) Design the "general" type "Go" and "Not-Go" gauges for component having 25H/f_8 fit. 7

Given : $i = 0.45\sqrt[3]{D} + 0.001D$, i in microns, D in mm, take wear allowance as 10% of gauge tolerances, upper deviation for f shaft $= -5.5D^{0.41}$, 25mm fails in the diameter step of 18 and 30.

(ii) What are the characteristics of random errors ? Explain. 3

(iii) List the different types of Numerical Control Programming techniques. Explain in detail. 5

(b) (i) Solve the following differential equation : 8

$$\frac{dy}{dx} = 1+y^2 \qquad \text{where } y=0 \text{ when } x=0,$$

Find y (0.2), y (0.4) and y (0.6). Use fourth-order Runge-Kutta method.

(ii) Find a real root of the equation : 7

$x = e^{-x}$. Using the Newton-Raphson method. Also write down the algorithm and flowchart.

Marks

(c) (i) Draw the schematic and block diagram of servo system. Explain in detail. Also determine the transfer function of second order servo system. 8

(ii) Explain in brief : 2

(1) Minimum Phase System.

(2) Non minimum phase system.

9. Answer the following sub-questions :

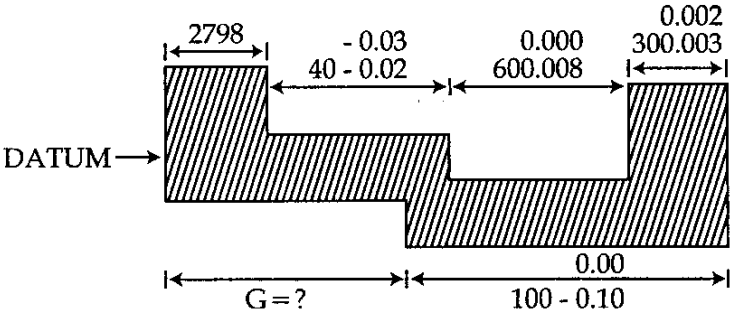
(a) (i) Figure given below indicates a component with tolerances. Calculate the dimension 2798 as per IT 919 and determine the gap dimension G with tolerance. 10

Given : Fundamental tolerance factor,

$i = 0.45\sqrt[3]{D} + 0.001D$ (microns).

Where D is the geometric mean of diameter step between 18 and 30 mm.

Grade of tolerance, IT8 = 25i (microns). Fundamental deviation, $9 = 2.5D^{0.34}$ microns.



(ii) What are the different types of motion control of tools in Numerical Control Systems ? Explain in detail. 5

(b) (i) Determine the constant a and b by method of least squares such that $y = ae^{bx}$ fits for the following data. 7

x	2	4	6	8	10
y	4.077	11.084	30.128	81.897	222.62

(ii) Solve the following equations : 8

$2x + 3y + z = 9$

$x + 2y + 3z = 6$

$3x + y + 2z = 8$ by the factorization method. Also draw the flowchart for the same.

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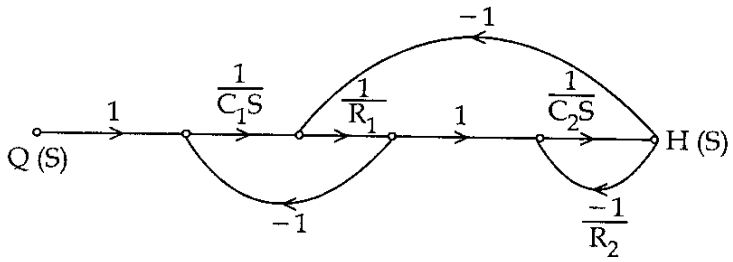
(c) (i) Draw and explain in detail the block diagram of an industrial control system. 5

(ii) Consider the system shown in figure below. Obtain the transfer function. 5



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