SIH

2010 **200053**

MECHANICAL ENGINEERING - II (Optional)

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.*

(ix) *For each slab of 10 and 15 marks, the examinee is expected to write answers in 125 and 200 words respectively.*

1. Answer **any four** of the following : **Marks**

(a) An engine of 250 mm bore and 375 mm stroke works on otto cycle. The clearance volume is 0.00263 m^3. The initial pressure and temperature are 1 bar and 50°C. If the maximum pressure is limited to 25 bar find air standard efficiency of cycle. **10**

(b) Prove that a wind turbine is capable of converting not more than 60% of the total power of a wind to useful power. **10**

(c) Sketch a schematic diagram of a typical open cycle gas turbine working on brayton cycle. Represent the process on T-S diagram. List various methods for improving the performance of gas turbine. Explain any one of it in detail. **10**

(d) (i) Explain with neat sketch the working principle of constant area, variable - pressure drop flow meter. List advantages and disadvantages for the same. **5**

(ii) Explain in detail the digital translational and rotary encoders. **5**

(e) Explain different types of tariff methods for electrical energy. **10**

P.T.O.

Marks

SECTION - A

2. Answer the following sub-questions :

(a) (i) A fixed mass of an ideal gas is held in a rigid container. If heat is added to the gas, will the entropy of the gas increases, decreases or remain constant. Explain your answer. **5**

(ii) One mole of air (ideal gas) contained in a rigid vessel is heated from 300 K to 370 K by placing the container on hot plate. Determine entropy change of air. **5**

(b) Explain with the help of neat diagram a Regenerative cycle. Derive also an expression for its thermal efficiency. **10**

(c) A steam boiler furnace is made of a layer of fireclay 12.5 cm thick and a layer of red brick 50 cm thick. If the wall temperature inside the boiler furance is 1100°C and that on outside wall is 50°C. Determine the amount of heat loss per square meter of the furance wall and temperature between two layer. **10**

K for fireclay = 0.533 W/mK.

K for red brick = 0.7 W/mK.

(d) Define the term total emissive power, absorptivity, reflectivity and transmissivity. State Kirchhof's law of radiation. **10**

3. (a) Distinguish between reversible and irreversible processes. Give two example of real processes that can reasonably be regarded as close to reversible processes. **10**

(b) Explain with neat diagram the working of a Binary vapour cycle **10**

(c) A cylinder 1 m long and 5 cm in diameter is placed in a atmosphere at 45°C. It is provided with 10 longitudinal straight fins of materials having K = 120 W/mK. The height of 0.76 mm fins is 1.27 cm from the cylinder surface. The heat transfer coefficient between cylinder and atmosphere air is 17 W/m^2K. Calculate the rate of heat transfer if surface temperature of cylinder is 150°C. **10**

(d) In a double pipe counter flow heat exchanger, 10,000 kg/h of an oil having specific heat of 2095 J/kg K is cooled from 80°C to 50°C by 8000 kg/h of water entering at 25°C. Determine the heat exchanger area for an overall heat transfer coefficient of 300 W/m^2K. Take c_p for water as 4180 J/kg K. **10**

Marks

SECTION - B

4. Answer the following sub-questions :

(a) Calculate the velocity gradient at distance of 0, 10 and 15 cm from the boundary if the velocity profile is parabolic, given by $u = Ay^2 + By + C$ and the vertex 15 cm from the boundary where the velocity is 100 cm/sec. Also calculate the shear stress at these points if the fluid has viscosity of 8.2 poise. **10**

(b) What are the assumptions made for a two stage reciprocating air compressor with intercooler. Prove that the minimum work required for a two stage reciprocating air compressor with intercooling is given by, **10**

$$W_{min} = \frac{2n}{n-1} P_1 V_1 \left[\left(\frac{P_3}{P_1} \right)^{\frac{n-1}{2n}} - 1 \right] J$$

Where, n = Index of compression for both cylinders

P_1 = Initial pressure in N/m^2.

P_3 = Final pressure in N/m^2.

(c) A double acting cylinder is to carry out an oscillatory motion after a 'start' signal is given. The cylinder should stop automatically after, say 3 cycles of operation. Using pneumatic counter, develop a pneumatic control circuit to implement the continuous to and fro motion of the piston for the required number of cycles. **10**

(d) What are the different methods of governing steam turbines ? Explain in detail throttle governing ? **10**

5. Answer the following sub-questions :

(a) What is the equivalent length of a pipe ? Explain the major problems in pipe-flow that is commonly encountered. **10**

(b) A pelton turbine is required to develop 9000 kW when working under a head of 300 metre. The impeller may rotate at 500 revolutions per minute. Assuming the jet ratio as 10 and overall efficiency of 85%, Calculate the following : **10**

(i) Quantity of water required.

(ii) Diameter of the wheel.

(iii) Number of jets and

(iv) Number and size of bucket - vanes on the runner.

Given that, $\rho = 1000$ kg/m^3

$g = 9.81$ m/sec^2.

Assuming speed parameter as 0.48

(c) What are pneumatic valves ? How are pneumatic valves classified ? List out a few derivatives of non-return valves. **10**

Marks

(c) (i) Draw and explain in detail the block schematic of PLC. How will you use PLC for controlling Lift used in four storey building ? Write down the flow chart. 7

(ii) Explain the significance of the following : 3

(I) Transfer function.

(II) Gain and phase margin.

9. (a) (i) Calculate the dimensions of plug and ring gauges to control the production of 50 mm shaft and hole pair of H_7 d_8 as per I.S. specifications for the following 8

50 mm lies in diameter step of 30 and 50 mm and the upper deviation for 'd' shaft is given by $-16\ D^{0.44}$ and lower deviation for the hole H is zero.

Tolerance factor $i = 0.45\sqrt[3]{D} + 0.001\ D$ and IT6 = 10 i and above IT6 grade the tolerance magnitude is multiplied by 10 at each fifth step.

(ii) Draw the block diagram of open loop system and closed loop system used in NC system. 2

(iii) What is DNC system ? Explain the difference between CNC and DNC system with the help of block diagram. 5

(b) (i) Find y (0.2), y(0.4), and y(0.6) for the following differential equation : 8

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

Use fourth order Runge - kutta method.

Also write down the algorithm and flow chart for the same.

(ii) Use a Gauss elimination method to solve the following simultaneous equations : 7

$$2x + y + z = 10$$
$$3x + 2y + 3z = 18$$
$$x + 4y + 9z = 16$$

(c) (i) What is PID ? Write the controller output equation for various PID configurations. 4

(ii) How will you measure and control the speed of single phase AC motor ? Explain. 4

(iii) Explain the principle of thermocouple. 2

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Marks

(d) The following data refer to a closed cycle gas turbine plant using helium as working fluid and incorporating two-stage compression with intercooling and two stage expansion with reheating. **10**

Temperature at entry to each compression stage is 270°C ; Pressure at entry to first compression stage and exit from the second turbine stage is 1 bar ; First compressor stage isentropic efficiency is 0.85% ; Temperature at inlet to each expansion stage is 1150°C. Isentropic efficiency of each expansion stage is 0.9 ; First compressor stage pressure ratio is 6 ; Reheat pressure is 6 bar ; For helium polotropic index n is 1.24 and R is 10.25.

Calculate the cycle thermal efficiency.

SECTION - C

6. (a) (i) A four cylinder four stroke SI engine has compression ratio of 8. The stroke and bore of the engine is 100 mm. The volumetric efficiency for each cylinder is 75%. The speed of the engine is 4800 rpm and Air-fuel ratio is 15 : 1. Calorific value of fuel is 42 MJ/kg. Mean effective pressure in cylinder is 10 bar. Mechanical efficiency of the engine is 80%. Find out (i) Indicated power (ii) Indicated Thermal efficiency (iii) Brake power. Take density of air = 1.12 kg/m^3. **7**

(ii) What is knocking ? What are its ill effect on the engine ? **3**

(b) (i) Sketch and explain multi point fuel injection system used in modern engines. State its advantages over carburetted fuel supply system. **8**

(ii) Take a brief review of Euro I, II and III emission norms. **7**

(c) (i) Explain the working of simple vapour compression refrigeration system with neat sketch. Represent the following on P-h an T-S diagram : **10**

(1) Simple saturated cycle

(2) Refrigerant superheated in evaporator

(ii) What is psychrometry ? Define following psychrometric terms : **5**

(1) Due point temperature

(2) Absolute humidity

(3) Relative humidity

7. (a) (i) What is supercharging ? State its objectives. Sketch typical supercharging arrangements. **5**

(ii) With neat sketch differentiate clearly between DI and IDI diesel engines. State any 2 advantages of DI diesel engine. **5**

(b) (i) Draw a layout of typical rear wheel automotive transmission system. With neat sketch explain the working of the differential. **8**

(ii) Sketch a schematic of modern electronic engine management system of the automobile. Show different sensors used in it. **7**

P.T.O.

Marks

(c) (i) Explain the structure of the psychrometric chart. Explain following psychrometric processes. 7
(1) Cooling and dehumidification.
(2) Sensible cooling.

(ii) A vapour compression refrigeration machine running on simple saturated cycle uses ammonia as refrigerant. Its condensation temperature is 30°C and evaporation temp. is −12°C. The temperature at the end of compression is 50°C. The machine forms Ice at −5°C at the rate of 1 tonne per hour, using water at 10°C. Specific heat of Ice is 2.1 KJ/kg K, latent heat of Ice is 335 KJ/kg. Specific heat of superheated ammonia vapour is 2.93 KJ/kg K. Find out : 8
(1) COP of the machine.
(2) mass of the refrigerant required.
(3) power required to drive the machine.

Salient properties of Ammonia are given below.

Sat. Temperature	KJ/kg Enthalpy		KJ/kg K Entropy	
	Liq.	Vap.	Liq.	Vap.
30°C	322	1469	1.2	4.98
–12°C	124	1422	0.505	5.5

SECTION - D

8. (a) (i) Differentiate between : 5
(I) Allowances and Tolerances.
(II) Systematic errors and Random errors.

(ii) Define numerical control. State the advantages of numerical control machine tools over conventional machine tools. 3

(iii) What are the important components of a NC system ? Describe with a sketch. 4

(iv) Discuss the following control system used in NC machine. 3
(I) Point to Point positioning.
(II) Straight cut.
(III) Contouring.

(b) (i) Find a real root of the equation $x^3 - 2x - 5 = 0$ using bisection method. 5

(ii) Determine the constants a and b by the method of least squares such that $y = a\ e^{bx}$ fits the following data. 7

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

(iii) Explain the following : 3
(I) Inherent errors.
(II) Truncation errors.

P.T.O.