MECHANICAL ENGINEERING

PAPER-I

SECTION A

1. Answer any four of the following: (Each answer should conform to a limit of around 150 words)

(a) What is Pressure Angle in cam action? How is it important in cam design?

(10)

(b) Why do high speed rotating and reciprocating machines need to be balanced? Illustrate with example.

(10)

(c) What are Fiber Reinforced Plastics (FRP)? State their characteristic properties and at least two applications.

(10)

(d) Draw a T-T-T diagram for a 0.8% carbon steel and indicate on it different structures and temperatures. How would you determine the minimum cooling rate for obtaining martensite structure?

(10)

(e) What does the term 'Kinematically equivalent system' imply in the analysis of mechanisms? State the conditions which it must satisfy to be kinematically equivalent.

(10)

2. (a) A Watt governor has an arm of uniform section of length L and a mass m and a ball of mass M. Show that when revolving with an angular velocity ω, it makes an angle θ to the vertical, given by

$$\cos\theta = \frac{\left(M + \frac{m}{2}\right)}{\omega^2 L\left(M + \frac{m}{3}\right)}$$

(15)

(b) Compare the weights of two equally strong beams of circular sections made of the same material, one being of solid section and the other of hollow section with inside diameter being $\frac{2}{5}$ of the external diameter (15)

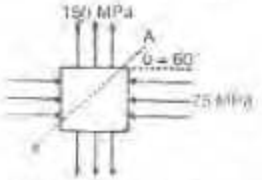
(c) A gun metal sleeve is fixed securely to a steel shaft and the compound shaft is subject to a torque. If the torque on sleeve is twice the torque on the shaft, find the ratio of external diameter of sleeve to the diameter of the shaft.

(10)

3. (a) A weight of 40 kgf is dropped through a height of 600 mm on to a close coiled compression spring which instantaneously compresses by 200 mm under the impact. If the diameter of the steel rod of which the spring is made is 25mm and the mean radius of the coils is 100 mm, find the maximum instantaneous stress produced by the impact and the number of coils in the spring. Take shear modulus of spring material as 8×10^5 kgf/cm^2

(20)

(b) At a give point in a machine element, following stresses measured : 150 MPa T and zero shear on horizontal plane and 75 MPa C on a plane perpendicular to this plane. Determine the stresses at this point on a plane inclined at 60° to the horizontal. (Fig.) (14)



(c) The equation of the turning moment curve of a three crank engine is (500 + 100 sin 3θ) kgfm; where θ is the crank angle. The mass moment of inertia of the flywheel is 1000 kg-m^2 and the mean engine speed is 300 r.p.m. Calculate the h.p. of the engine.

(6)

4. (a) Determine an expression for the minimum number of teeth on the pinion of a mating spur gear to avoid interference between the flank of the pinion and the tips of the gear teeth.

(12)

(b) A leather belt is to transmit 20 H.p. from a motor running at 940 r.p.m. The width of belt is 8.5 cm. Diameter of driving pulley of the motor is 30cm. The driven pulley runs at 310 r.p.m. and the distance between the centre of the two pulleys is 3 m. The weight of leather is 1 x 10^{-3} kgf/cm^2. Coefficient of friction between leather and pulley is 0.3 N. Assume open belt drive. Neglect sag and slip in the belt.

(20)

(c) What are various heat treatments given to steel? State the purpose of each of these. Why do we follow a two stage heating and cooling practice for heat treatment of high speed steel?

(8)

SECTION B

5. Answer any four of the following: (Each answer should conform to a limit of around 150 words)

(a) Prove that the dynamic shear strain is given by

$$e = \frac{h^2 - 2h \sin\alpha + 1}{h \cos\alpha}$$

where his the chip reduction coefficient and a is the orthogonal rake angle.

(10)

(b) Define and illustrate the following for a cam operated clamping device:

(i) Rise, (x)

(ii) Throw, (θ)

(iii) Eccentricity, (e)

Write down the relationship between them. (10)

(c) Explain the meaning of the following terms clearly:

(i) MCU

(ii) Buffer storage

(iii) Canned cycle

(iv) Macro

(v) MDI

(10)

(d) What is Plasma Arc Machining? What factors influence the quality of cut in Plasma Arc Machining?

(10)

(e) Define the terms Material Requirement Planning (MRP) and Capacity Requirement Planning (CRP). What do MRP and CRP accomplish? What role the BOM and MPS play in their implementation?

(10)

6. (a) Define the terms Machinability, Shear Angle and Chip Reduction Coefficient.

In an orthogonal cutting operation material was cut with tool having back rake angle = 15° at a feed rate of 0.25 mm/revolution. Thickness of chip was 0.35 mm. Cutting speed was 70 m/mm and cutting force was = 30 kgf, Feed force = 10 kgf. Using this data calculate (1) Shear angle, (ii) Work done in shear, and (iii) Shear strain.

(20)

(b) For what type of work measurement situations use of work sampling is admissible?

A work sampling study is to be made of a messenger system in a large metropolitan office building. The building manager feels the messengers are idle 30% of the time and he wishes to have a 95.5% confidence that the accuracy is within ±4%. How many observations should be made?

(14)

(c) Compare and contrast M.T.M. and Work Factors System of Work Measurement on the points of basic concept, efficiency and accuracy of results.

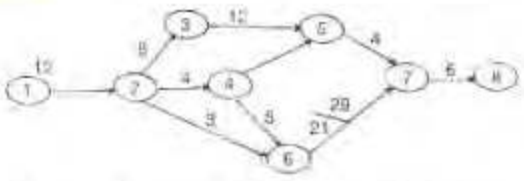
(6)

7. (a) A nuclear fuel company manufactures uranium pallets to a specified diameter of 0.500 ± 0.005 centimetre. In 25 random samples of 9 pallets each, the overall mean of the means $(\bar{\bar{x}})$ and the range $(\bar{R})$ were found to be 0.501cm and 0.003cm respectively. Construct an $\bar{x}$ and R chart which includes the specified tolerances. For the given situation take the values of A, B and C as 0.337, 1.816 and 0.184 respectively.

(20)

(b) The earliest star (ES) and latest start (LS) times for activity 6-7 of a network are as shown. Determine appropriate values of all other activities of the network, and show them in a similar manner

(14)



(c) Why in PERT type of network modelling, the statistical distribution representing the three time estimates is taken as β distribution?

(6)

8. (a) A turning tool has a sharp nose, side cutting edge angle = 60° and end cutting edge angle of 100. What should be the feed rate in order to obtain a theoretical centre line average roughness of 5 μm?

(6)

(b) Discuss the advantages of EDM as compared to other non-traditional methods of machining with regard to

(i) Material Removal Rate

(ii) Accuracy

(iii) Surface finish

(8)

(c) Write down a Fortran-77 program to evaluate the roots of the quadratic equation

$x^2 - 5x + 6 = 0$

(6)

(d) Consider the assignment of 4 operators to four machines. The assignment costs are tabulated below:

		Machines			
		M_1	M_2	M_3	M_4
Operators	O_1	7	7	—	4
	O_2	9	6	4	5
	O_3	11	5	7	—
	O_4	9	4	8	9

Operator O_1 cannot be assigned machine M_3 and operator O_3 cannot be assigned machine M_4. Find the optimal assignment.

(20)

MECHANICAL ENGINEERING

PAPER-II

SECTION A

1. Answer any four parts:

(a) Define the following: Indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, volumetric efficiency and relative efficiency as applied to IC engines.

(10)

(b) An SI engine has a fuel air ratio of 0.067. For a brake power of 74 kW, find the amount of airrequired,ifbrakethermalefficiencyis20%.If density of air is 1.15 kg/m^3 and that bf fuel is 4.6 kg/m^3, find the volume of air and the volume of mixture.

(10)

(c) Using Maxwell's equation, prove that, for a perfect gas internal energy is a function of temperature only and independent of pressure and volume.

(10)

(d) Prove that reversible adiabatic work while undergoing change from state 1 to state 2 in a steady flow system per unit mass is given by

$$-\int_1^2 v\,dp$$

(10)

(e) 2 kg of water at 80°C is mixed adiabatically with 3 kg of water at 30°C in a constant pressure process at 1 bar. Find the change in entropy of total mass of water due to mixing process. Specific heat of water at constant pressure is, 4.18 kJ/kg-K.

(10)

2. (a) Derive an expression for a Diesel cycle to determine its thermal efficiency and work output as a function of its compression ratio and inlet conditions.

(5)

(b) In an SI engine working on ideal Otto cycle, the compression ratio is 5.5. The pressure and temperature at the beginning of compression are 1 bar, 27°C respectively. Pressure at the end of compression is 30 bar. Find the pressure and temperature at the end of each process of the cycle. Also find air thermal efficiency, mean effective pressure. Take $\gamma = 1.4$.

(25)

(c) What is carburetion? Briefly explain various factors affecting effective carburetions.

(10)

3. (a) Discuss briefly different air refrigeration systems used giving details of the cycles and their components.

(20)

(b) Compare vapour compression system and vapour absorption system giving details of the cycle and components used. How will you use solar heat to run the refrigeration system?

(20)

4. (a) A metal plate of 4mm thickness and having k = 95.5 W/m°C is exposed to gas temperature of 100°C at one end and cooling at 25°C by water on the other side. The heat transfer coefficient of gas arid water are 14500 W/m2 °C and 2250 W/m2 °C respectively. Find the rate of heat transfer, overall heat transfer coefficient, temperature on each side of the plate.

(20)

(b) The pressure difference 'Δp' in pipes of diameter 'D', length 'l' is found to depend upon velocity 'V', viscosity 'μ' density 'p' and pipe roughness of the surface 'ε' Using Buckingham's π-theorem find suitable non-dimensional parameters.

(20)

SECTION B

5. Answer any four parts:

(a) With the help of a simple sketch discuss the functioning of a thermostatic expansion valve. What does it control? Distinguish between internally and externally equalised thermostatic expansion valve.

What are the other types of expansion valves used?

(10)

(b) Explain the term : Thermodynamic wet bulb temperature. How does it differ from wet bulb temperature measured by a psychrometer ? Distinguish between dry bulb temperature and dew point temperature. How will you determine dew point temperature of specified moist air?

(10)

(c) Sketch Rankine cycle on T — s and p — v diagram. Derive expression for mass flow rate, power input to the pump, rate of heat supply, turbine output, rate of heat rejection and thermal efficiency for a given net power output of the plant.

(10)

(d) What do you understand by the term View factor of Shape factor used for radiation heat exchange? How are the shape factors for two bodies exchanging heat by radiation inter-related? Discuss the relationship for view factors in an enclosure.

(10)

(e) Discuss the characteristics of fuels used in S.T. engines.

(10)

6. (a) What is shock wave? How is it developed? Explain its significance.

(10)

(b) What is "Degree of Reaction" in Turbo Machine. Explain the effect of reaction on the shape of profiles of blades.

(10)

(c) 16.5 kg/sec of substance at 650°C having C_p= 3.55 kJ/kg K is used to heat 20.5 kg/sec of incoming fluid of C_p = 4.2 kJ/kg K from 100°C. If overall heat transfer coefficient is 0.95 kW/m^2 °C and heat transfer area is 44 m^2, calculate the outlet temperatures for (a) counter flow and (b) parallel flow arrangement in the indirect contact heat exchanger.

(20)

7. (a) Au axial flow compressor stage has blade root, mid and tip velocities 150, 200, 250 m/s respectively. Stagnation temperature rise for the stage is 20 K. Axial velocity is 150 m/s and is constant along the radial direction. The work done factor is 0.93. At the mid stream section the degree of reaction is 50%. Calculate the air, and blade angles at root, mid and tip sections.

(20)

(b) The following data refer to a free vortex turbine rotor blades at mid-section:

Inlet angle 60°; Outlet angle 65°

Blade diameter 100 cm: Nozzle angle 70°

Hub-Tip ratio 0.6; Speed 3600 rpm.

Find the blade angles, degree of reaction, blade to gas, speed ratio for mid-section.

(20)

8. A boiler is supplied with 200 kg/hr of coal of heating value 32,000 kJ/kg and an analysis of coal indicates C—82%, H_2—6%, O_2—8%, Ash—4%. 1800 kg/hr of dry saturated steam is produced at 10 bar pressure from feed water at 32°C. The total air supplied is 1.3 times the minimum air required. The temperature of flue gas is 340°C. Room temperature is 25°C. Find minimum air requirement, mass of dry burnt gas/kg of coal burnt, equivalent evaporation from and at 100°C, thermal efficiency, heat carried away by flue gas/kg of coal. Take C_p = 1.005 kJ/kg K at 10 bar, H; Enthalpy of saturated steam = 2778.1 kJ/kg. Sensible heatofwaterat32°C, h' = 134 kJ/kg.

(40)