

Serial No.

47648

A-DMHH-N-NFB

MECHANICAL ENGINEERING

Paper—II

(Conventional)

Time Allowed : Three Hours

Maximum Marks : 200

INSTRUCTIONS

Please read each of the following instructions carefully before attempting questions :

Candidate should attempt FIVE questions in all.

Question No. 1 in Section A is compulsory.

Out of the remaining, attempt TWO from Section—B and TWO from Section—C.

All questions carry equal marks. The number of marks carried by a part of a question is indicated against it.

Answer must be written in ENGLISH only.

Unless other-wise mentioned, symbols and notations have their usual standard meanings.

Neat sketches may be drawn, wherever required.

All parts and sub-parts of a question are to be attempted together in the answer book.

Attempts of questions shall be counted in chronological order.

Unless struck off, attempt of a question shall be counted even if attempted partly.

Any page or portion of the page left blank in the answer book must be clearly struck off.

SECTION—A

1. Answer all of the following (Each part carries 4 marks) :
- (a) Draw a crank rocker mechanism and identify all instantaneous centres. 4
 - (b) A steel tube 2.5 cm external diameter and 1.8 cm internal diameter encloses a copper rod 1.6 cm diameter to which it is rigidly joined at each end. If, at a temperature of 20°C there is no longitudinal stress, calculate the stresses in the rod and tube when the temperature is raised to 210°C.
Given : $E_s = 210 \text{ Pa}$ and $\alpha_s = 12 \times 10^{-6}/^\circ\text{C}$
and $E_c = 100 \text{ GPa}$ and $\alpha_c = 20 \times 10^{-6}/^\circ\text{C}$ 4
 - (c) A drive shaft of 40 mm diameter transmitting 25 kW at 300 rpm is connected to a gear by a flat key of width 22 mm and thickness 14 mm. It is made of steel having 300 MPa yield stress. Determine the length of the key to withstand shear. Use a factor of safety 2. 4
 - (d) A plate clutch has a single surface with an outside diameter of 250 mm and inside diameter of 100 mm with a coefficient of friction 0.2. Find the required axial force to develop a maximum pressure of 0.65 MPa. Under this pressure, find the torque capacity of the clutch. 4
 - (e) What are ceramics ? Classify ceramics into four groups and describe their utilities and applications. 4
 - (f) Describe the characteristics of tool materials. 4
 - (g) Name the defects that may develop in arc welding of steel parts. 4
 - (h) Differentiate between orthogonal and oblique cutting. 4

- (i) What is ABC analysis ? 4
 (j) Explain Queueing model and its applications. 4
 4×10=40

SECTION—B

Answer any **TWO** questions.

2. (a) A power screw is made with Acme threads 34 mm-6 mm, single start to lift and lower a load of 10 kN. The screw and nut are well lubricated. Sliding friction is 0.15 and rolling friction is 0.02. Take semi thread angle as 14.5°. Determine :
 (i) raising torque
 (ii) lowering torque
 (iii) efficiency of the power screw. 10
- (b) Design a gib and cotter joint for two rods of square cross section transmitting an axial tensile load of 40 kN. The gib, cotter and rods are made of same material having allowable tensile strength of 120 MPa and shear strength of 60 MPa and crushing strength of 160 MPa. Assume the thickness of cotter as one-third of side of the square cross section. 20
- (c) Determine the diameter of a circular shaft subjected to a bending moment $M = 13$ kN-m and a torque $T = 30$ kN-m according to maximum shear stress theory. Take $\sigma_y = 700$ MPa and use a Factor of safety of 2.6. 10
3. (a) Compare the flexural strengths of the following three beams of equal weight and same material :
 (i) I-section 300×160 mm with flanges 20 mm thick and web 16 mm thick.
 (ii) Rectangular section having depth twice the width.
 (iii) Circular solid section. 10

- (b) The internal diameter of the cylinder of a hydraulic ram is 10 cm. Find the thickness required to withstand an internal pressure of 500 atm (1 atm = 98.07 kPa), if the yield point for the material (in tension as well as compression) is $\sigma_y = 500$ MPa. Use a Factor of safety of 2. 10
- (c) Draw the profile of a cam operating a knife-edged follower having a lift of 30 mm. The cam raises the follower with S.H.M. for 150° of its rotation followed by a period of dwell for 60° . The follower descends for the next 100° rotation of the cam with uniform velocity, again followed by a dwell period. The cam rotates at a uniform speed of 120 rpm and has a least radius of 20 mm.

What are the maximum velocity and acceleration of the follower during lift and return ? 10

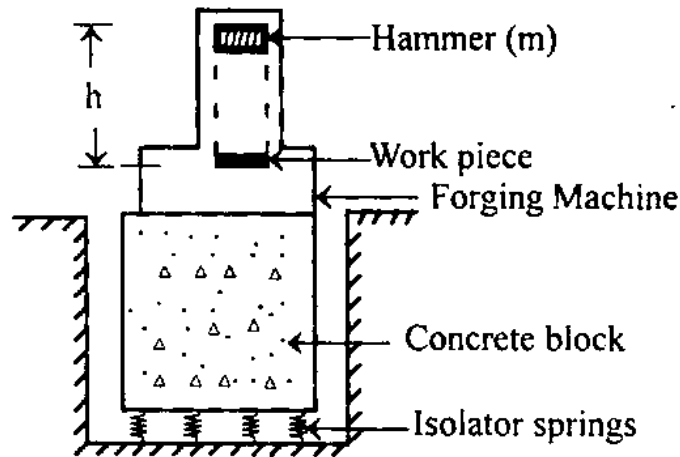
- (d) A 360° hydrodynamic bearing has a journal diameter of 60 mm and length 60 mm. It is running at a speed of 1200 rpm. The radial clearance is 0.04 mm and minimum oil thickness is 0.008 mm. Sommerfeld number is 0.0446. Find the viscosity of the oil suitable for the bearing. 10
4. (a) The state of stress at a point in a structural component of elastic material are given as follows : A normal tensile stress of 160 MPa and a shearing stress of 120 MPa on one plane, a normal compressive stress of 110 MPa and the complementary shearing stress of 120 MPa on a second plane orthogonal to the first plane, and no stress on the third plane which is orthogonal to the above two planes.

Determine :

- (i) the principal stresses and the positions of the planes on which they act, and

- (ii) the positions of planes on which there is no normal stress. 10
- (b) Describe the methods of the following heat treatment procedures of steels :
- (i) Nitriding
- (ii) Cyaniding. 10
- (c) Four rotating masses A, B, C and D rotating in four different parallel planes are completely balanced. Angular position of masses C and D are 90° and 195° respectively from B in anticlockwise direction looking from right hand side. The rotating masses and their radius of mass centres are given below :
- $$m_b = 25 \text{ kg} \quad m_c = 40 \text{ kg} \quad m_d = 35 \text{ kg}$$
- $$r_b = 150 \text{ mm} \quad r_c = 100 \text{ mm} \quad r_d = 180 \text{ mm}$$
- Planes B and C are 250 mm apart and mass centre radius for mass A is 150 mm. Determine using graphical method :
- (i) the mass of A and its angular position with respect to B, and
- (ii) position of planes A and D with respect to plane B. 10
- (d) Figure below shows an impact type forging machine mounted rigidly on a large concrete block with total mass, $M = 10,000 \text{ kg}$. The concrete block is placed on ground through isolators of total stiffness, $K = 1.7 \text{ MN/m}$. A hammer with a mass, $m = 500 \text{ kg}$ falls from a height, $h = 2 \text{ m}$ on to the work piece as shown in the figure. Assuming that

the impact is inelastic and instantaneous, analyse and determine the motion (amplitude) of the machine. Also find its natural frequency. 10



SECTION—C

Answer any **TWO** questions.

5. (a) Determine the dimensions of an optimum cylindrical riser attached to the side of a steel plate casting having dimensions $25 \text{ cm} \times 12.5 \text{ cm} \times 5 \text{ cm}$. The volume shrinkage of steel during solidification is 3% and the volume of riser is 3 times that of dictated by the shrinkage consideration alone. 10
- (b) (i) What kind of products are manufactured by wire drawing process ?
- (ii) How much force will approximately be required to draw a wire from 1.5 mm diameter steel wire to 1.0 mm diameter wire if the average yield strength of the work material is 300 MPa ? 10
- (c) A bar of 70 mm diameter is being cut orthogonally and is reduced to 68 mm by a cutting tool. In case mean length of the chip is 68.9 mm, find the cutting ratio. Determine shear angle also if the rake angle is 10° . 10

- (d) Name the machine tools by which teeth of straight toothed spur gears are produced in mass scale. Also mention what motions are imparted to the cutter and the blank in each of those machine tools. 10
6. (a) Draw neat sketches of different Oxy-acetylene flames, label them and describe the two stages of combustion in gas welding. Show graphically the effects of current, pressure and time on the weld strength in resistance welding. What are the consequences of excessive or insufficient pressure during resistance welding ? 10
- (b) Show schematically the Merchant's force circle in orthogonal cutting. Derive the equations for shear and friction forces in terms of the material properties and cutting process parameters. State also the assumptions made while arriving at the final equations. 15
- (c) Discuss the effect of welding speed on grain structure and properties of weld metals. 5
- (d) State the principles of Riser Design and discuss the factors affecting riser efficiency. 10
7. (a) Distinguish between CPM and PERT.

The table given below is for manufacture and installation of a generator for a small scale industry to generate power in case of supply failure. Show the critical path and calculate the project duration time.

Activity	Description of Activity	Duration of Activity	Immediate Predecessor
A	Design Plant Layout	12 days	—
B	Select Site	8 days	A

Activity	Description of Activity	Duration of Activity	Immediate Predecessor
C	Select Vendors	4 days	A
D	Select Personnel	3 days	A
E	Prepare Site	12 days	B
F	Manufacture/ Assemble Generator	18 days	C
G	Prepare Operation Manual	5 days	C
H	Install Generator	4 days	E, F
I	Train Operators	9 days	D, G
J	Obtain Licence	6 days	H, I

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(b) There is a proposal to purchase a machine for ₹ 30,000/-. Manufacturing cost of a component from this machine is estimated at ₹ 6.0. The component can be sold in the market for ₹ 9.0. The life of the machine is estimated as 18 years. An attractive rate of return is reckoned as 12% and estimated average insurance and taxes as 3%. What quantity should be produced in year to make this proposal profitable ?

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(c) (i) Describe seven phase job plan of value engineering.

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(ii) Enlist the advantages of DNC over CNC.

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(d) If cost price and selling price of an item is input through the keyboard, write a C-program to determine whether the seller has made profit or incurred loss. Also determine the percentage of profit made or loss incurred.

Test the C-program by an illustrative example.

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