Roll No.

Candidate should write his/her Roll No. here.

Total No. of Questions : **7**

No. of Printed Pages : **8**

SEM-2016(03)-I
MECHANICAL ENGINEERING
Paper – I

Time : **3** Hours]

[Total Marks : **300**

Instructions to the candidates :

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

*Candidates are require to attempt **FIVE** questions in all.*

*Question No. **1** is **compulsory**. The remaining **FOUR** questions are require to attempt by selecting atleast **ONE** question from each of the three Section A, B and 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 otherwise mentioned, symbols and notations have their usual standard meanings.

Assume suitable data, if necessary and indicate the same clearly.

Neat sketch may be drawn, wherever required.

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

Any pages left blank in the answer book must be clearly struck out.

Use of geometrical instrument box is permitted.

1. Compulsory question **all** parts carry equal marks : **10 × 6 = 60**

(A) Derive an expression for circumferential stress (σ_1) and longitudinal stress (σ_2) for a thin wall pressure vessel subjected to an internal pressure 'p'. Also show that the circumferential stress (σ_1) is twice the longitudinal stress (σ_2). **6**

(B) What do you understand by the term 'theories of failure' ? Explain Haigh's theory of failure. **3 + 3 = 6**

(C) Describe the importance of inventory control. What is ABC analysis ? Explain and give its applications. **2 + 4 = 6**

(D) A rotating shaft carrying four masses A, B, C and D at radius 100 mm, 125 mm, 200 mm and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C and D are 10 kg, 5 kg and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft must be in complete balance. **6**

(E) Derive the condition for maximum power transmission by a belt drive considering the effect of centrifugal tension. **6**

(F) State the working principle of EDM process with a suitable and relevant diagram. Write the advantages and disadvantages of non-metallic graphite electrode used in EDM process. **4 + 2 = 6**

(G) Differentiate between jigs and fixtures. Describe 3-2-1 principle of locating the workpiece with the help of neat sketch. **6**

(H) Define the terms 'PERT' and 'CPM'. How CPM differs from PERT ? Explain. **3 + 3 = 6**

(I) How does the design of a flange coupling differ from that of a muff coupling ? Explain. **6**

(J) An I-section joist 400 mm × 200 mm × 20 mm and 6 m long is used as a strut with both ends fixed. What is Euler's crippling load for the column ? Take Young's modulus for the joist as 200 GPa. **6**

SECTION – A

(Attempt at least one question)

2. (a) Draw Mohr's circle for stresses on an oblique section AB of a body subjected to a direct tensile stress (σ_x) in one plane accompanied by a simple positive shear stress (τ_{xy}). How will you find out the normal stress and shear stress on that plane when θ is the angle of oblique section AB with x-x axis in clockwise direction ? Deduce an expression for the formula used to find out the normal stress and shear stress in support of your answer. **25**

(b) A solid En-24 steel shaft of diameter 'D' is to be replaced by a hollow shaft of same material with internal diameter, d = (D/2). Deduce an expression for the following :

(i) Total torque that can be transmitted by the hollow shaft and

(ii) Savings in material, if the maximum allowable shear stress is same for both the shaft. **20**

(c) What do you mean by whirling of shafts ? Explain. Calculate the whirling speed of a shaft 20 mm diameter and 0.6 m long carrying a mass of 1 kg at its mid-point. The density of the shaft material is 40×10^3 kg/m^3 and Young's modulus is 200 GN/m^2. Assume the shaft to be simply supported. **5 + 10 = 15**

3. (a) A laminated spring 1 m long is made of steel plates each 5 cm wide and 1 cm thick. If the bending stress in the plate is limited to 100 N/mm^2, how many plates would be required to enable the spring to carry a central point load of 2 kN ? If $E = 2.1 \times 10^5$ N/mm^2. What is deflection under the load ? **15**

(b) A belt drive is required to transmit 10 kW of power from a motor running at 600 rpm. The belt is 12 mm thick and has a mass density of 0.001 g/mm^3. Safe stress in the belt is not to exceed 2.5 N/mm^2. Diameter of the driving pulley is 250 mm, whereas the speed of the driven pulley is 220 rpm. The two shafts are 1.25 m apart. The coefficient of friction is 0.25. Determine the width of the belt. **20**

(c) In the epicyclic gear train shown in Fig. 1, a gear C which has teeth cut internally and externally is free to rotate on an arm driven by shaft S_1. It meshes externally with the casing D and internally with pinion B. The gears have the following number of teeth : $T_B = 24$, $T_C = 32$ and 40, $T_D = 48$. In Fig. 1, T_B meshes with 32 teeth T_C. Find the velocity ratio between (i) S_1 and S_2 when D is fixed (ii) S_1 and D when S_2 is fixed. What will be the torque required to fix the casing D, if a torque of 300 N-m is applied to the shaft S_1 ? **25**

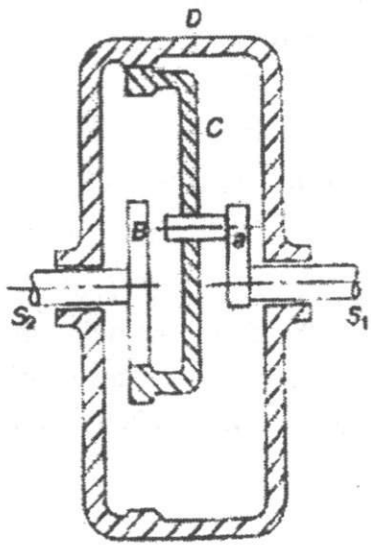

Fig. 1

SECTION – B

(Attempt at least one question)

4. (a) Deduce an expression for equivalent twisting moment (Te) and equivalent bending moment (Me) for a hollow shaft subjected to an axial load in addition to combined torsion and bending loads. Assume as usual all notations for this deduction and explain all notations clearly. **15**

(b) A solid AISI 1040 steel shaft is supported on two bearings 1.8 m apart and rotates at 250 r.p.m. A 20° involute gear D, 300 mm diameter is keyed to the shaft at a distance of 150 mm to the left on the right hand bearing. Two pulleys B and C are located on the shaft at a distance of 600 mm and 1350 mm respectively to the right of the left hand bearing. The diameters of the pulleys B and C are 750 mm and 600 mm respectively. A power 30 kW is supplied to the gear, out of which 18.75 kW is taken off at the pulley C and 11.25 kW from pulley B. The drive from B is vertically downward while from C the drive is downward at an angle of 60° to the horizontal. In both cases the belt tension ratio is 2 and the angle of lap is 180°. The combined fatigue and shock factors for torsion and bending may be taken as 1.5 and 2 respectively. Design a suitable shaft taking working stress to be 42 MPa in shear and 84 MPa in tension. Draw a space diagram showing shaft, pulleys and gear arrangement in support of your answer. **30**

(c) A plate 100 mm wide and 12.5 mm thick is to be welded to another plate of same size by means of parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld so that the maximum stress does not exceed 56 MPa. Consider the joint first under static loading and then under fatigue loading. Assume stress concentration factor for parallel fillet weld as 2.7 and solve the problem. **15**

5. (a) Draw Merchant's circle diagram and explain the relationship among the different components of forces and the resultant cutting force. **15**

(b) Utilizing Merchant's theory and from the fundamentals of metal cutting proves that the coefficient of friction $\mu = \frac{F}{N} = \frac{F_C \sin\alpha + F_T \cos\alpha}{F_C \cos\alpha - F_T \sin\alpha}$.

Where, F_C = cutting force along the direction of cutting velocity, F_T = cutting force normal to the cutting velocity, α = rake angle. **20**

(c) Mild steel is being machined at a cutting speed of 200 m/min with a tool of rake angle 10°. The width of cut and the uncut chip thickness are 2 mm and 0.2 mm respectively. If the average value of the co-efficient of friction between the tool and the chip is 0.5 and the shear stress 'τ_s' of the work material is 400 N/mm^2; determine the cutting and the thrust components of the machining force. **20**

(d) How would you measure the surface roughness heights ? **5**

SECTION – C

(Attempt at least one question)

6. (a) Define the term 'production planning and control'. State its objectives. Explain the relationship between 'production planning' and 'control'.

5 + 4 + 6 = 15

(b) State and explain the basic concepts of material requirement planning ? What are the inputs to the materials requirement planning ? Give structure of a material requirement planning in support of your answer and explain. **6 + 4 + 10 = 20**

(c) What is economic order quantity ? Derive the formula used to determine EOQ. **5 + 5 = 10**

(d) A ship building company requires 1250 semi-conductors chips per month throughout the year for manufacturing the electronic control units. If the ordering cost is ₹ 50 per order, unit cost is ₹ 5.00 per semi-conductor chips and annual inventory carrying costs are 10%, find EOQ. If the company decided to operate with a back order inventory policy then taking back order cost to be ₹ 7.50 per unit per year, find revised EOQ. **15**

7. (a) A steel cantilever of cross-section 20 × 60 mm is bolted to a frame with two M16 bolts. The cantilever is used to support a load of 5 kN attached to a string which passes through two pulleys (ref fig. 2). Determine the maximum resultant shear stress on the bolts. **20**

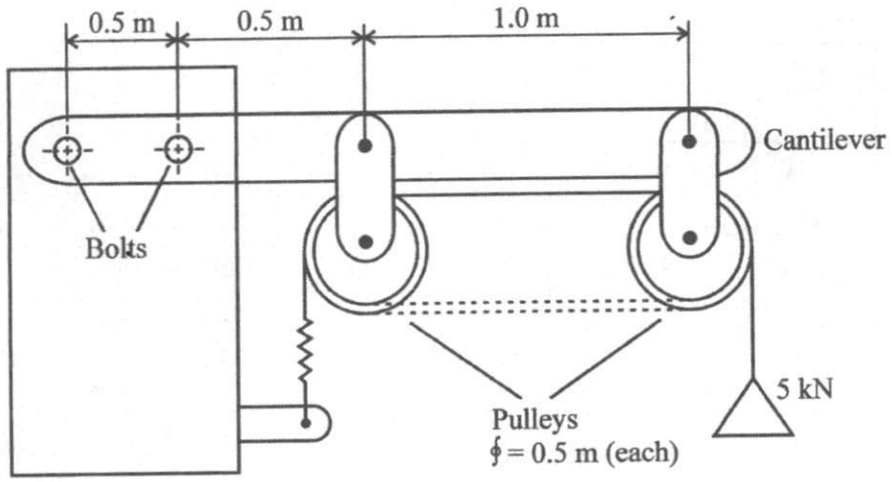

Fig. – 2

(b) A firm manufactures three products A, B and C. Time required to manufacture product A is twice that for B and thrice that for C, if the entire labour is engaged in making product A, 1600 units of this product can be produced. These products are to be produced in the ratio 3 : 4 : 5. There is demand for at least 200, 150 and 100 units of products A, B and C, and the profit earned per unit is ₹ 90, ₹ 40 and ₹ 30 respectively.

Raw material	**Requirement per unit of product (kg)**			**Total availability (kg)**
	Product, A	**Product, B**	**Product, C**	
P	6	5	2	4000
Q	4	7	3	5000

Formulate the linear programming model. **15**

(c) Find the basic feasible solution to the following transportation problem (Table-1) by North-West corner rule. Also find the optimal transportation plan.

Table-1

U_i/V_j	1	2	3	4	5	Available
A	4	3	1	2	6	80
B	5	2	3	4	5	60
C	3	5	6	3	2	40
D	2	4	4	5	3	20
Required	60	60	30	40	10	**200 (Total)**

Where, V_j = Number across the top row of the matrix and U_i = Symbols across the left side column of the matrix. **25**
