SEAL

Roll No.

400034

Candidate should write his/her Roll No. here.

Total No. of Questions : **7**

No. of Printed Pages : **7**

SEM–2017(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 required to attempt **FIVE** questions in all.*

*Question No. **1** is **compulsory**. The remaining **FOUR** questions are required to attempt by selecting at least **ONE** question from each of the three Sections A, B and C.*

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

*Answers 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. Answer the following questions : 6×10=60

(a) A hollow circular bar of outside diameter twice the inside diameter is used as a beam. The bar is subjected to bending moment of 40 kN m. If the allowable bending stress in the beam is to be limited to 100 MN/m^2, find the inside diameter of the bar. 6

(b) Make a list of six principal theories of failure. Explain major consideration and application of maximum principal stress theory. 3+3=6

(c) A flat bar 32 mm wide and 12 mm thick is loaded by a steady tensile load of 85 kN. The material is mild steel with yield point stress of 315 N/mm^2. Find the factor of safety based on the yield point. 6

(d) Design the longitudinal joint for a 1·25 m diameter steam boiler carrying a steam pressure of 5 N/mm^2. The allowable stress of the plate material is 80 N/mm^2 in tension. Length of the shell of boiler is 5 m. Take allowable stress for shielded arc weld = 95 N/mm^2. 6

(e) Find the length of belt (open and cross) necessary to drive a pulley of 80 cm diameter running parallel at a distance of 12 m from the driving pulley of diameter 480 cm. 3+3=6

(f) Make a list of various types of gear trains. Derive an expression for velocity ratio of a simple gear train. 2+4=6

(g) A uniform disc of diameter 30 cm and weighing 5 N is mounted on one end of an arm of length 60 cm. The other end of the arm is free to rotate in a universal bearing. If the disc rotates about the arm with a speed of 300 r.p.m. clockwise, looking from the front, with what speed will it precess about the vertical axis? 6

(h) For what type of materials ultrasonic machining (USM) is best suitable process of material removal? Make a sketch showing major parts of USM setup. 2+4=6

(i) Classify comparators. Explain the working and constructional details of any one comparator. 6

(j) For a small project with five jobs, the following data is given :

Job	Immediate predecessors	Duration (days)	
		Mean	Std. deviation
A	—	10	2
B	—	5	1
C	A	16	2
D	A	12	2
E	B, C	15	1

(i) Draw the project network in activity on arc mode.

(ii) Under PERT assumptions, determine the distribution of project duration. 6

SECTION—A

Attempt at least **one** question

2. (a) A short column of I-section 25 cm × 20 cm has cross-section area of 52 cm^2 and maximum radius of gyration 10·7 cm. A vertical load w kN acts through the centroid of the section together with a parallel load of $w/4$ kN acting through a point on the centreline of the web distant 6 cm from the centroid. Calculate the greatest allowable value of w if the maximum stress is not to exceed 65 MN/m^2. What is then the minimum stress? 15+10=25

(b) A close-coiled helical spring is to have a stiffness of 900 N/m in compression, with a maximum load of 45 N and a maximum shearing stress of 120 N/mm^2. The solid length of the spring (i.e., coils touching) is 45 mm. Find the—

(i) wire diameter;

(ii) mean coil radius;

(iii) number of coils.

Take modulus of rigidity of material of the spring $= 0 \cdot 4 \times 10^5$ N/mm^2.

5+5+5=15

(c) A simple band brake is applied to a drum of 560 mm diameter which rotates at 240 r.p.m. Angle of contact of the band is 270°. One end of the band is fastened to a fix pin and the other end to the brake lever 140 mm from the fixed pin. The brake lever is 800 mm long and is placed perpendicular to the diameter that bisects the angle of contact. Assuming the coefficient of friction as 0·3, determine the necessary pull at the end of the lever to stop the drum if 40 kW of power is being absorbed. Also, find the width of the band if its thickness is 3 mm and the maximum tensile strength is limited to 40 N/mm^2. 20

3. (a) A V-belt of 6·0 cm^2 cross-section has a groove angle of 40° and an angle of lap of 150°, $\mu = 0 \cdot 10$. The mass of the belt per meter run is 1·2 kg. The maximum allowable stress in the belt is 850 N/cm^2. Calculate the horse-power that can be transmitted at a belt speed of 30 m/s. 20

(b) Derive an expression for maximum and minimum values of swaying couple. 10

(c) A V-twin engine has the cylinder axis at right angles and the connecting rods operate a common crank. The reciprocating mass per cylinder is 1·5 kg and the crank radius 75 mm. The length of the connecting rod is 0·3 m. Show that the engine may be balanced for primary forces by means of a revolving balance mass. If the engine speed is 500 r.p.m., what is the value of the maximum resultant secondary force? 30

SECTION—B

Attempt at least **one** question

4. (a) Design the rectangular key for a shaft of 50 mm diameter. The shearing and crushing stresses for the key material are 42 MPa and 70 MPa, take $w = 16$ mm and $t = 10$ mm, where w = width and t = thickness of the key. 15

(b) Design a cast iron protective type flange coupling to transmit 15 kW at 900 r.p.m. from an electric motor to a compressor. The service factor may be assumed as 1·35. The following permissible stresses may be used : 30

Shear stress for shaft, bolt and key material = 40 MPa
Crushing stress for bolt and key = 80 MPa
Shear stress for cast iron = 8 MPa

(c) The following data relate to a shaft held in long bearings :

Length of the shaft = 1·2 m

Diameter of the shaft = 14 mm

Mass of a rotor at midpoint = 16 kg

Eccentricity of centre of mass of rotor from centre of rotor = 0·4 mm

Modulus of elasticity of the shaft material = 200 GN/m^2

Permissible stress in the shaft material = 70×10^6 N/m^2

Determine the critical speed of the shaft. 15

5. (a) A steel rod is turned with a single-point cutting tool having rake angle 10°. The chip thickness was measured as 1·5 mm. The dynamometer gave indication of cutting forces as 980 N for tangential component and 440 N for thrust component, compute friction force at chip tool interface and shear strength of the material (assume uncut chip thickness as 0·6 mm and uncut width of chip as 1·8 mm). 20

(b) During straight turning of 25 mm diameter steel bar at 300 r.p.m. with HSS tool, a tool life of 10 minutes was obtained. When the same bar was turned at 250 r.p.m., the tool life increased to 52·5 minutes. What will be the tool life at a speed of 275 r.p.m? 10

(c) Comment on the following statements related to electrochemical machining (ECM) : 20

(i) "ECM is reverse of electroplating."

(ii) "AC power supply cannot be used in ECM."

(iii) "Tool wear in ECM does not involve material loss."

(iv) "ECM is a highly predictive process of material removal."

(d) Write any five differences between traditional and non-traditional machining processes. 10

SECTION—C

Attempt at least **one** question

6. *(a)* A company uses the purchased item continuously in the manufacturing of a large number of products. The item has the following characteristics :

Demand/year = 8000 Pc

Purchase price = ₹ 100/Pc

Safety stock = 1·6 × lead time demand

Lead time from order to delivery = 4 weeks

Purchasing quantity = 1000 Pc

Inventory carrying cost/year = 20% of the item value

A reorder point system that continuously reviews stock on hand is used to generate purchase orders. The product is produced and in demand in all 52 weeks of the year :

(i) Determine the reorder point, the average tied-up capital in inbound stock, the inventory turnover rate in the stock, the average run-out time in the stock and the annual inventory carrying cost for the item.

(ii) As the company buys several items from the same supplier it is considering changing its review principle from continuous review to periodic review stock on hand of all purchased items every second week. By doing this, it is thought that it will be possible to coordinate deliveries of several items from this supplier. How will the answer in *(i)* change if a switch is made to periodic review? 10+10=20

(b) A company makes two types of leather belts, *A* and *B*. Belt *A* is high quality belt and belt *B* is of lower quality. The respective profits are ₹ 4 and ₹ 3 per belt. Each belt of type *A* requires twice as much time as belt of type *B*, and if all the belts were of type *B*, the company could make 1000 per day. The supply of leather is sufficient for only 800 belts per day (both *A* and *B* combined). Belt *A* requires a fancy buckle and only 400 per day are available.

There are only 700 buckles a day available for belt *B*. What should be the daily production of each type of belt? Formulate as a linear programming problem (solution not required). 20

(c) The following table shows the jobs of a network along with their time estimates (in days) :

Job	1–2	1–6	2–3	2–4	3–5	4–5	5–8	6–7	7–8
t_o	3	2	6	2	5	3	1	3	4
t_m	6	5	12	5	11	6	4	9	19
t_p	15	14	30	8	17	15	7	27	28

(i) Draw network diagram.

(ii) Find critical path. Also, find the expected duration of the project.

(iii) Calculate the standard deviation of the project length.

(iv) Find the probability that the project is completed in 31 days. 5×4=20

7. (a) Calculate the fundamental deviation and tolerances and hence the limits of size for the shaft and hole for the following fit : 20

60 mm H_8–f_7

The diameter steps are 50 mm and 80 mm.

(b) A television repairman finds that the time spent on his jobs has an exponential distribution with a mean of 30 minutes. If he repairs sets in the order in which they came in, and if the arrival of sets follows a Poisson's distribution approximately with an average rate of 10 per 8-hour day, what is the repairman's expected idle time each day? How many jobs are ahead of the average set just brought in? 20

(c) A cantilever member 0·1 m long having cross-section of 0·05 m×0·25 m supports a load of 27·5 kN. What is the maximum shear stress and where does it occur? 20

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