B.TECH/ME/5TH SEM/MECH 3103(BACKLOG)/2021

DESIGN OF MECHANICAL SYSTEMS - I
(MECH 3103)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Which of the following material has the maximum ductility? [CO-1](LOCQ)
(a) Mild Steel (b) Copper (c) Zinc (d) Aluminium.

(ii) Series factor for R20 is [CO-1](LOCQ)
(a) $\sqrt[10]{20}$ (b) $\sqrt{20}$ (c) $\sqrt[20]{10}$ (d) $\sqrt[3]{20}$

(iii) According to distortion energy theory of failure, the relationship between yield strength on shear (S_{sy}) and tensile yield strength (S_{yt}) is [CO-2](LOCQ)
(a) $S_{sy} = 0.5\ S_{yt}$ (b) $S_{sy} = 0.577\ S_{yt}$ (c) $S_{sy} = 0.75\ S_{yt}$ (d) $S_{sy} = 0.4\ S_{yt}$

(iv) Hooke's law holds good up to [CO-1](LOCQ)
(a) breaking point (b) yield point
(c) elastic limit (d) plastic limit.

(v) Maximum principal stress theory of failure is best applicable to [CO-2](LOCQ)
(a) components made of plain carbon steel
(b) components made of aluminum alloy
(c) components made of cast iron
(d) components made of brass.

(vi) Stress concentration factor is defined as [CO-3](IOCQ)
(a) ratio of highest stress near the discontinuity to endurance limit
(b) ratio of highest stress near the discontinuity to yield strength
(c) ratio of highest stress near the discontinuity to nominal stress obtained by elementary equation
(d) ratio of endurance limit to highest stress near the discontinuity

(vii) The approximate relationship between endurance limit of rotating beam specimen (S'_e) and ultimate tensile strength (S_{ut}), in case of cast iron and cast steel components, is [CO-4](LOCQ)

(a) $S'_e = 0.4S_{ut}$ (b) $S'_e = 0.7S_{ut}$
(c) $S'_e = 0.5S_{ut}$ (d) $S'_e = S_{ut}$

(viii) A stress that varies in sinusoidal manner with respect to time from tensile to compressive (or vice versa) and which zero mean is called [CO-4](LOCQ)
(a) reversed stress (b) fluctuating stress
(c) repeated stress (d) varying stress.

(ix) For self-locking screw [CO-5](LOCQ)
(a) $\phi > \alpha$ (b) $\phi < \alpha$ (c) $\mu < \tan\alpha$ (d) $\mu = \text{cosec}\,\alpha$
where α = helix angle φ = friction angle μ = coefficient of friction

(x) Two shafts A and B are made of same material. The diameter of shaft A is twice that of B. The torque transmitted by shaft A will be [CO-6](LOCQ)
(a) twice that of B (b) four times that of B
(c) eight times that of B (d) sixteen times that of B.

Group – B

2. (a) What do understand by Elasticity and Modulus of Elasticity? [(CO1)(Remember/LOCQ)]
(b) Write a detailed note on Resilience and Modulus of resilience. [(CO1)(Remember/LOCQ)]

6 + 6 = 12

3. The shaft of an overhang crank subjected to a force P of 1.2 kN is shown in Fig.1. The shaft is made of plain carbon steel 30C8 and the tensile yield strength is 400 N/mm^2. The factor of safety is 2.1. Determine the diameter of the shaft using the maximum shear stress theory. All dimensions shown in the figure are in mm. [(CO2)(Apply/HOCQ)]

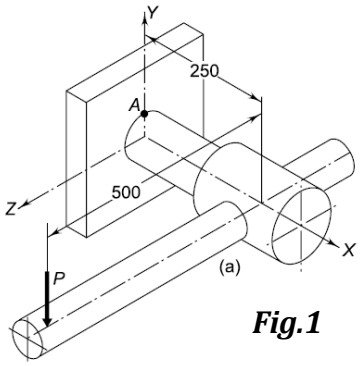

Fig.1

12

Group – C

4. (a) Describe in brief about various methods for reduction of stress concentration effect in an object. [(CO3)(Remember/LOCQ)]
(b) A non-rotating shaft supporting a load of 3.2 kN is shown in Fig.2. The shaft is made of brittle material, with an ultimate tensile strength of 380 N/mm^2. The factor of safety is 3. Determine the dimensions of the shaft. [(CO3)(Solve/IOCQ)]

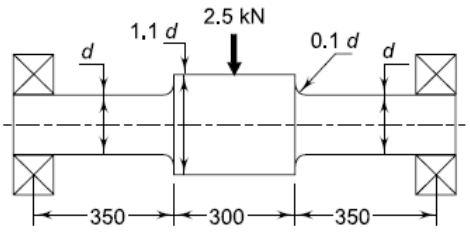

Fig.2

4 + 8 = 12

5. (a) Discuss about various types of cyclic loading with neat schematic representations. [(CO4)(Classify/LOCQ)]

(b) The work cycle of a mechanical component subjected to completely reversed bending stresses consists of the following three elements:
(i) ± 280 N/mm2 for 85% of time
(ii) ± 340 N/mm2 for 12% of time
(iii) ± 470 N/mm2 for 3% of time
The material for the component is 50C4 (Sut = 660 N/mm^2) and the corrected endurance limit of the component is 280 N/mm^2. Determine the life of the component. [(CO4)(Analyse/IOCQ)]

4 + 8 = 12

Group – D

6. (a) The square-threaded jack as shown in figure 3, is used to raise and lower the 100-kg block. Determine a) the torque Mu required to begin moving the block up, and b) the torque Md required to begin moving the block down. Also determine if the block will remain stationary when the torque is removed. The screw has lead L = 10 mm, mean radius r = 8 mm, and is single threaded. The coefficient of static friction between the screw and the supporting thread of the base is = 0.25. [(CO5)(Analyze/IOCQ)]

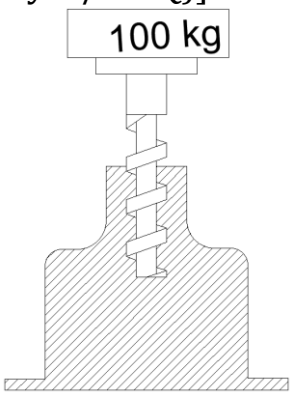

Fig.3

(b) What do you understand by the single start and double start threads? Briefly explain the meaning of bolt M24 x 2. [(CO5)(Understand/LOCQ)]

8 + (2 + 2) = 12

7. A steel plate subjected to a force of 3 kN and fixed to a vertical channel by means of four identical bolts is shown in Fig.4. The bolts are made of plain carbon steel 45C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 2. Determine the diameter of the shank. [(CO5)(Design/HOCQ)]

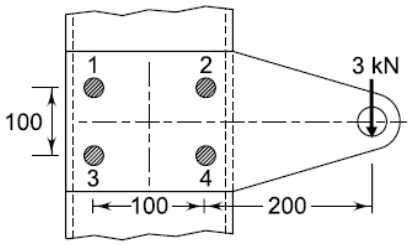

Fig.4

12

Group – E

8. A line shaft supporting two pulleys A and B is shown in Fig.5. Power is supplied to the shaft by means of a vertical belt on the pulley A, which is then transmitted to the pulley

B carrying a horizontal belt. The ratio of belt tension on tight and loose sides is 4:1. The limiting value of tension in the belts is 3.2 kN. The shaft is made of plain carbon steel 40C8 (S_{ut} = 650 N/mm^2 and S_{yt} = 380 N/mm^2). The pulleys are keyed to the shaft. Determine the diameter of the shaft according to the ASME code if, k_b = 1.4 and k_t = 1.2. [(CO6) (Design/HOCQ)]

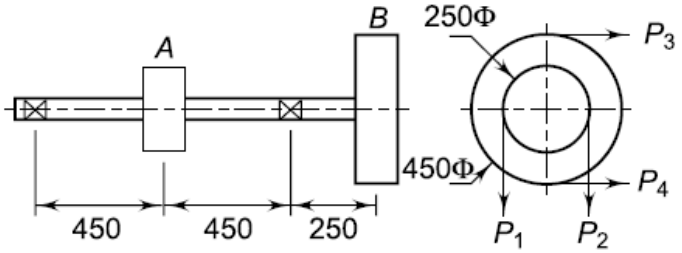

Fig.5

12

9. (a) A semi-elliptic leaf spring consists of two extra full-length leaves and six graduated length leaves, including the master leaf. Each leaf is 7.5 mm thick and 50 mm wide. The centre-to-centre distance between the two eyes is 1 m. The leaves are pre-stressed in such a way that when the load is maximum, stresses induced in all the leaves are equal to 350 N/mm2. Determine the maximum force that the spring can withstand. [(CO6)(Estimate/IOCQ)]

   (b) What is the Wahl factor? Why is it used? [(CO6)(Remember/LOCQ)]

8 + 4 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	30%	43.33%	26.67%

Course Outcome (CO):

On completion of this course students will be able to

1. Choose suitable material of a product to be designed as per the application and strength requirement.
2. Relate relevant 'Mode of Failure' and 'Theory of Failure' when solving a problem regarding design of machine components under different types of loadings and boundary conditions.
3. Identify proper stress intensity factors for objects with dimensional discontinuity subjected to different loadings and boundary conditions.
4. Analyse life of a machine component with or without dimensional discontinuity subjected to various dynamic loadings constrained with different boundary conditions.
5. Evaluate detailed specifications for fasteners like screw, nut-n-bolt, for welding and power screw by analysing the machine component subjected to various loading and boundary conditions.
6. Design a solid and hollow shaft, coil and leaf spring, shaft couplings and various belts for a belt drive for given power rating, loadings and boundary conditions.

*LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question

Department & Section	Submission link:
ME - Backlog	https://classroom.google.com/u/1/w/NDY0NDYxNTg1MTM4/tc/NDY0NDYxOTgxOTM3