Printed Page:- 05 **Subject Code:- AME0601**

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NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA
(An Autonomous Institute Affiliated to AKTU, Lucknow)
B.Tech
SEM: VI - THEORY EXAMINATION (2023 - 2024)
Subject: Design of Machine Elements

Time: 3 Hours **Max. Marks: 100**

General Instructions:

IMP: *Verify that you have received the question paper with the correct course, code, branch etc.*

1. *This Question paper comprises of* ***three Sections -A, B, & C.*** *It consists of Multiple Choice Questions (MCQ's) & Subjective type questions.*

2. *Maximum marks for each question are indicated on right -hand side of each question.*

3. *Illustrate your answers with neat sketches wherever necessary.*

4. *Assume suitable data if necessary.*

5. *Preferably, write the answers in sequential order.*

6. *No sheet should be left blank. Any written material after a blank sheet will not be evaluated/checked.*

SECTION-A 20

1. Attempt all parts:-

1-a. Which of the following is a design consideration for machine elements subjected to fatigue loads? (CO1) 1

(a) Yield strength
(b) Hardness
(c) Ductility
(d) Endurance limit

1-b. What is the most important factor in selecting a material for machine element design? [CO1] 1

(a) Cost
(b) Availability
(c) Compatibility with existing equipment
(d) Suitability for the application

1-c. What is the Soderberg criterion? (CO2) 1

(a) A criterion used for infinite life design
(b) A criterion used for finite life design
(c) A criterion used to predict the fatigue limit of a material
(d) A criterion used to predict the yield strength of a material

1-d. What is the effect of increasing the fillet radius in machine part design? (CO2) 1

(a) It reduces the stress concentration factor

(b) It increases the stress concentration factor

(c) It has no effect on the stress concentration factor

(d) It reduces the fatigue strength of the material

1-e. What is contact ratio in gear systems?[CO3] 1

(a) Ratio of the length of the contact arc to the pitch circle circumference

(b) Ratio of the module to the pitch diameter

(c) Ratio of the tooth thickness to the circular pitch

(d) Ratio of the addendum to the dedendum

1-f. What is the standard addendum for involute spur gears? [CO3] 1

(a) 1 module

(b) 1.25 module

(c) 1.5 module

(d) 2 module

1-g. Which of the following is not a factor affecting the beam strength of bevel gears? (CO4) 1

(a) Face width of the gear

(b) Cone distance of the gear

(c) Diametral pitch of the gear

(d) Module of the gear

1-h. Which factor affects the strength of a worm gear? (CO4) 1

(a) The number of teeth on the worm gear

(b) The material used for the worm gear

(c) The ratio of the worm gear

(d) All of the above

1-i. Which of the following types of sliding contact bearings is designed to handle axial loads?[CO5] 1

(a) Journal bearing

(b) Thrust bearing

(c) Pivot bearing

(d) Collar bearing

1-j. Which of the following factors affects the selection of a roller bearing cage? (CO5) 1

(a) Speed

(b) Temperature

(c) Load

(d) All of the above

2. Attempt all parts:-

2.a. List the main advantages of forged components. (CO1) 2

2.b. Define the the term stress concentration and stress concentration factor? [CO2] 2

2.c. Where do you use grease as gear lubricant? (CO3) 2

2.d. What is the difference between a single-start and multi-start worm? (CO4) 2

2.e. What is a hydrostatic bearing? (CO5) 2

SECTION-B 30

3. Answer any five of the following:-

3-a. Explain the following materials used in Engineering 6
(a) Steel
(b) copper
(c) Aluminum . [CO1]

3-b. What are the disadvantages of hollow shaft over solid shaft? [CO1] 6

3-c. What are the causes of stress concentration? Also Explain the effect of stress concentration during design of component. [CO2] 6

3-d. What is pulsating shear stress? Why are springs subjected to pulsating shear stress? (CO2) 6

3.e. State important reasons for adopting involute curve for gear tooth profile. (CO3) 6

3.f. How do you calculate the strength and wear tooth load for worm gears? (CO4) 6

3.g. Discuss the important properties of bearing materials. (CO5) 6

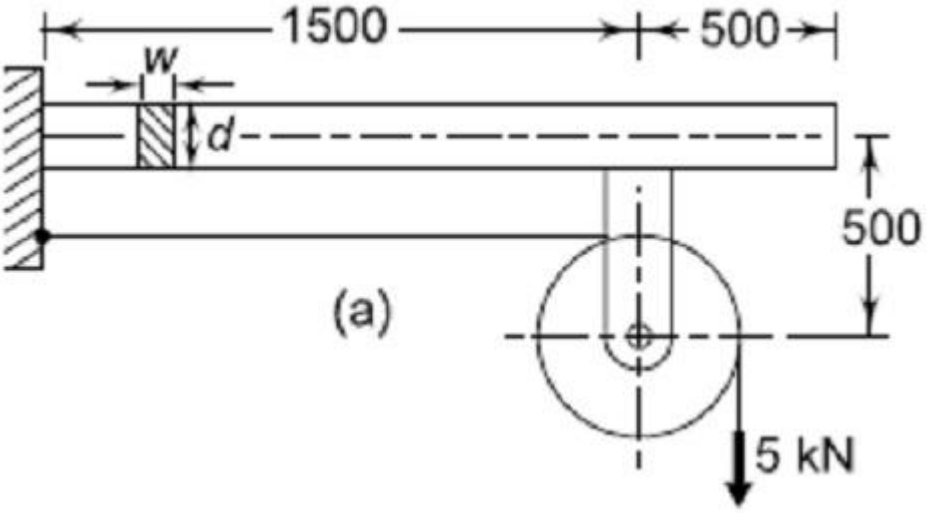
SECTION-C 50

4. Answer any one of the following:-

4-a. It is required to select a material by the weighted point method. There are four candidate materials, viz., low alloy steel, plain carbon steel, stainless steel and chromium steel, which have passed through screening test. For a particular application, the designer has given a 5-point weightage for ultimate tensile strength, 3-point weightage for hardenability and 2-point weightage for cost-economy. Table gives the data for the candidate materials. 10

		Materials			
Sr. No.	Material Property	Low alloy steel	Plain carbon steel	Stainless steel	Chromium steel
1	Ultimate tensile strength (N/mm^2)	850	850	1200	950
2	Hardenability Index	60	80	30	100
3	Cost (Rs / unit)	40	50	100	80

4-b. A cantilever beam of rectangular cross-section is used to support a pulley as shown in Fig. The tension in the wire rope is 5 kN. The beam is made of cast iron FG 200 and the factor of safety is 2.5. The ratio of depth to width of the cross-section is 2. Determine the dimensions of the cross-section of the beam. [CO1] 10



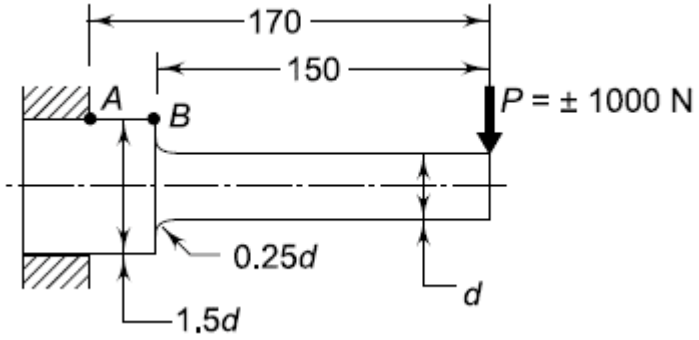
5. Answer any <u>one</u> of the following:-

5-a. A helical compression spring, made of circular wire, is subjected to an axial force, which varies from 2.5 kN to 3.5 kN. Over this range of force, the deflection of the spring should be approximately 5 mm. The spring index can be taken as 5. The spring has square and ground ends. The spring is made of patented and cold-drawn steel wire with ultimate tensile strength of 1050 N/mm2 and modulus of rigidity of 81370 N/mm2. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. 10

Design the spring and calculate
(i) wire diameter;
(ii) mean coil diameter;
(iii) number of active coils;
(iv) total number of coils;
(v) solid length of the spring;
(vi) free length of the spring;
(vii) required spring rate; and
(viii) actual spring rate [CO2]

5-b. 10

A cantilever beam made of cold drawn steel 20C8 (Sut = 540 N/mm^2) is subjected to a completely reversed load of 1000 N as shown in Fig. The notch sensitivity factor q at the fillet can be taken as 0.85 and the expected reliability is 90%. Determine the diameter d of the beam for a life of 10000 cycles. (CO2)



6. Answer any <u>one</u> of the following:-

6-a. It is required to design a pair of spur gears with 20° full-depth involute teeth based on the Lewis equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is connected to a 10 kW, 1440 rpm motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4 : 1. The pinion as well as the gear is made of plain carbon steel 40C8 (Sut = 600 N/mm^2). The factor of safety can be taken as 1.5. Design the gears, specify their dimensions and suggest suitable surface hardness for the gears. [CO3] 10

6-b. A pair of spur gears with 20 full depth involute teeth consist of a 20 teeth pinion meshing with a 41 teeth gear. the module is 3 mm. while the face width is 40 mm. the material for pinion as well as gear is steel with an ultimate tensile strength of 600 N/mm$^{2\cdot}$. The gears are heat treated to a surface hardness of 400 BHN.The pinion rotates at 1450 rpm and the the service factor for the application is 1.75. Assume that velocity factor accounts for the dynamic load and the factor of safety is 1.5. determine the rated power that the gears transmit. [CO3] 10

7. Answer any <u>one</u> of the following:-

7-a. A pair of bevel gears, with 20° pressure angle, consists of a 20 teeth pinion meshing with a 30 teeth gear. The module is 4 mm, while the face width is 20 mm. The material for the pinion and gear is steel 50C4 (Sut = 750 N/mm^2). The gear teeth are lapped and ground (Class-3) and the surface hardness is 400 BHN. The pinion rotates at 500 rpm and receives 2.5 kW power from the electric motor. The starting torque of the motor is 150% of the rated torque. Determine the factor of safety against bending failure and against pitting failure.. [CO4] 10

7-b. Design 20^0 involute worm and gear to transmit 20 Kw with Worm rotating at 1400 r.p.m. and to obtain a speed reduction 12:1. The distance between shaft is 225 mm. [CO4] 10

8. Answer any <u>one</u> of the following:-

8-a. A single-row deep groove ball bearing is subjected to a pure radial force of 3 kN from a shaft that rotates at 600 rpm. The expected life L10h of the bearing is 30 000 h. The minimum acceptable diameter of the shaft is 40 mm. Select a suitable ball bearing for this application. [CO5] 10

8-b. A 360° hydrodynamic bearing operates under the following conditions: 10
radial load = 50 kN
journal diameter = 150 mm
bearing length = 150 mm
radial clearance = 0.15 mm
minimum fi lm thickness = 0.03 mm
viscosity of lubricant = 8 cP
What is the minimum speed of operation for the journal to work under hydrodynamic
conditions?