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

Roll. No:

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY, GREATER NOIDA

(An Autonomous Institute Affiliated to AKTU, Lucknow)

B.Tech

SEM:VI CARRY OVER THEORY EXMINATION- AUGUST 2023

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.*

7. Design data handbook is permitted.

SECTION A **20**

1. Attempt all parts:-

1-a. Which of the following is a material commonly used for shafts? [CO1] 1

(a) Copper

(b) Aluminum

(c) Steel

(d) Rubber

1-b. Which of the following is a design consideration for shafts subjected to twisting moments? [CO1] 1

(a) Torsional rigidity

(b) Bending rigidity

(c) Axial rigidity

(d) Transverse rigidity

1-c. Which of the following is a criterion for helical spring design subjected to fatigue loading? [CO2] 1

(a) Shear stress criteria

(b) Bending stress criteria

(c) Tensile stress criteria

(d) Fatigue stress criteria

1-d. Which of the following is a correct formula to calculate the stress concentration factor of a helical spring with a fillet radius?[CO2] 1

(a) Kt = σmax / σnom

(b) Kt = σnom / σmax

(c) Kt = τmax / τnom

(d) Kt = τnom / τmax

1-e. What is wear strength of a gear tooth? [CO3] 1

(a) The ability of the gear tooth to resist bending under load

(b) The ability of the gear tooth to resist shearing under load

(c) The ability of the gear tooth to resist wear under load

(d) The ability of the gear tooth to resist fatigue failure under load

1-f. Which of the following is an important consideration in the design of helical gears?[CO3] 1

(a) The strength of the gear teeth

(b) The material of the gears

(c) The manufacturing method of the gears

(d) All of the above

1-g. What is the terminology used for the smallest diameter of a bevel gear?[CO4] 1

(a) Pitch diameter

(b) Base diameter

(c) Outside diameter

(d) Root diameter

1-h. Which term refers to the distance between the top of one tooth and the bottom of the tooth on the opposite side of the gear?[CO4] 1

(a) Clearance

(b) Backlash

(c) Addendum

(d) Dedendum

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. What is hydrodynamic lubrication?[CO5] 1

(a) Lubrication using mixed lubricant

(b) Lubrication using a solid lubricant

(c) Lubrication using a liquid lubricant

(d) Lubrication using a gas lubricant

2. Attempt all parts:-

2.a. What are preferred numbers?[CO1] 2

2.b. What is surge in spring?[CO2] 2

2.c. What is a crossed helical gear?[CO3] 2

2.d. What are the advantages and disadvantages of using bevel gears in a transmission system?[CO4] 2

2.e. What is a collar bearing, and how does it differ from a pivot bearing?[CO2] 2

SECTION B **30**

3. Answer any <u>five</u> of the following:-

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

3-b. Find out the numbers of the R5 basic series from 1 to 10. [CO1] 6

3-c. What is repeated stress? Draw a stress–time curve for repeated stress. [CO2] 6

3-d. Discuss the various types of mathematical model for fluctuating load.[CO2] 6

3.e. What are the advantages of planetary reduction gears as compared to ordinary gearboxes? [CO3] 6

3.f. What are the advantages and disadvantages of using worm gears in a transmission system? [CO4] 6

3.g. What is the definition of bearing life, and how is it measured? [CO5] 6

SECTION C **50**

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

4-a. Explain the different theory of failure in detail. [co1] 10

4-b. Design a hollow shaft required to transmit 11.2 MW at a speed of 300 r.p.m. The maximum shear stress allowed in the shaft is 80 MPa and the ratio of the inner diameter to outer diameter is 3/4. [CO1] 10

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

5-a. A rod of a linkage mechanism made of steel 40Cr1(S_{ut} =550N/mm^2) is subjected to a completely reversed axial load of 100KN. The rod is machined on a lathe and the expected reliability is 95%. There is no stress concentration. determine the diameter of the rod using a factor of safety of 2 for an infinite life condition. [CO2] 10

5-b. A forged steel bar, 50 mm in diameter, is subjected to a reversed bending stress of 250 N/mm2. The bar is made of steel 40C8 (Sut = 600 N/mm2). Calculate the life of the bar for a reliability of 90%. [CO2] 10

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

6-a. A pair of helical gears consist of a 20 teeth pinion meshing with a 100 teeth gear. The pinion rotates at 720 r.p.m. The normal pressure angle is 20° while the helix angle is 25°. The face width is 40 mm and the normal module is 4 mm. The pinion as well as gear are made of steel having ultimate strength of 600 MPa and heat treated to a surface hardness of 300 B.H.N. The service factor and factor of safety are 1.5 and 2 respectively. Assume that the velocity factor accounts for the dynamic load and calculate the power transmitting capacity of 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. 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. 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

7-b. Design a bevel gear system to transmit 10 kW of power at a speed of 1000 RPM from a motor to a machine. The motor has a shaft diameter of 30 mm and rotates counterclockwise, while the machine has a shaft diameter of 50 mm and rotates clockwise. The gear system should have a 2:1 gear ratio, and the 10

maximum allowable stress for the gear material is 150 MPa. [CO4]

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

8-a. In a particular application, the radial load acting on a ball bearing is 5 KN and the expected life for 90% of the bearing is 8000 hrs. Calculate the dynamic load carrying capacity of bearing when the shaft rotates at 1450 R.P.M. [CO5] 10

8-b. The following data is given for a full hydrodynamic bearing used for electric motor 10

Radial Load=1200 rpm

journal speed=1450rpm

Journal Diameter=50mm

Static load on the bearing =400 N

The values of surface roughness (cla) of the journal and the bearing are 2 and 1 micron respectively. The minimum oil film thickness should be five times the sum of the surface roughness of the journal and bearing.

(i) Length of the bearing.

(ii) Radial clearance.

(iii) Viscosity of lubricant.

(iv) Flow of lubricant,

Select a suitable oil for this application assuming the operating temperature as $65\ ^{0}c$ [CO5]