Graphic Era
HILL UNIVERSITY
Established by an Act of the State Legislature of Uttarakhand (Adhiniyam Sankhya 12 of 2011)
University under section 2(f) of UGC Act, 1956

End Term (Even) Semester Examination May-June 2025

Roll no.....

Name of the Program and semester: **B.Tech / VI**
Name of the Course: **Design of Machine Elements-II**
Course Code: **TME 602**

Time: 3 hour **Maximum Marks: 100**

Note:
(i) All the questions are compulsory.
(ii) Answer any two sub questions from a, b and c in each main question.
(iii) Total marks for each question is 20 (twenty).
(iv) Each sub-question carries 10 marks.

Q1. **(2X10=20 Marks)**

a. Derive the expression for deflection and maximum shear stress in a close-coiled helical spring under axial load. **CO-1**

b. A helical tension spring is used in a spring balance to measure weights. One end of the spring is fixed to a rigid support, while the free end carries the weight to be measured. The maximum weight the spring balance should measure is 1800 N, and the length of the scale should be approximately 120 mm. The spring index is given as 7. The spring is made of oil-hardened and tempered steel wire with an ultimate tensile strength of 1400 N/mm² and a modulus of rigidity of 82,500 N/mm². The permissible shear stress in the spring wire is 50% of the ultimate tensile strength. Design the spring and determine the following parameters:

(i) Wire diameter
(ii) Mean coil diameter
(iii) Number of active coils
(iv) Required spring rate
(v) Actual spring rate **CO-1**

c. Explain and derive the expression for equalized stress in leaf springs. How is the design modified to ensure equal stress distribution? **CO-1**

Q2. **(2X10=20 Marks)**

a. Derive the equation for the moment and torque in a helical torsion spring. Explain how it differs from a conventional helical compression spring. **CO-1**

b. A belt drive transmits power from a pulley of 600 mm diameter rotating at 200 RPM. The coefficient of friction between the belt and the pulley is 0.25, and the angle of lap on the smaller pulley is 160°. The maximum tension in the belt is 2500 N.
Determine:
(i) The velocity of the belt
(ii) The ratio of belt tensions
(iii) The effective tension in the belt
(iv) The power transmitted by the belt **CO-2**

c. Derive the ratio of belt tensions in a flat belt drive system considering the effect of centrifugal tension. **CO-2**

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Q3. **(2X10=20 Marks)**

a. Derive the Lewis equation for strength of a gear tooth. Discuss the assumptions and limitations of the derivation. **CO-3**

b. 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 12 kW, 1800 rpm motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4:1. Both the pinion and gear are made of plain carbon steel 40C8 (Sut = 600 N/mm²). A factor of safety of 1.5 is to be used.
Design the gears, specify their dimensions, and suggest a suitable surface hardness for the gears. **CO-3**

c. Explain the concept of formative number of teeth in helical gears and derive the expression for beam strength of helical gear tooth. **CO-3**

Q4. **(2X10=20 Marks)**

a. Perform a dynamic load analysis on a spur gear using Buckingham's equation. Derive expressions and explain the significance of each term. **CO-3**

b. A pair of parallel helical gears transmits 8 kW of power at 960 rpm to the pinion. The normal module is 4 mm and the normal pressure angle is 20°. The pinion has right-hand teeth and the gear has left-hand teeth. The helix angle is 25°. The pinion rotates clockwise when viewed from the input side.
Determine the components of the tooth force acting between the pinion and gear. **CO-4**

c. Perform force analysis for worm gear drive and derive equations for tangential, radial, and axial forces acting on the worm and worm wheel. **CO-4**

Q5. **(2X10=20 Marks)**

a. For rolling contact bearings, derive the expression for static and dynamic load capacity. Explain how equivalent load is determined for combined radial and axial loads. **CO-5**

b. The following data is given for a 360° hydrodynamic bearing:
length to diameter ratio = 1,
Journal speed = 1350 rpm,
journal diameter = 100 mm,
Diametric clearance = 100 mm,
External load = 9 kN
The value of minimum film thickness variable is 0.3. Find the viscosity of oil that need be used. **CO-5**

c. Derive the relationship between bearing life and load (L10 life) and explain the process of selecting a bearing using manufacturer catalog. **CO-6**