Q.5 i.   Give classification of helical springs explain each one of them with **4**
          the help of neat sketch.

     ii. Design and draw a valve spring of a petrol engine for the following **6**
          operating conditions:
          Spring load when the valve is open = 400 N
          Spring load when the valve is closed = 250 N
          Maximum inside diameter of spring = 25 mm
          Length of the spring when the valve is open = 40 mm
          Length of the spring when the valve is closed = 50 mm
          Maximum permissible shear stress = 400 MPa

OR   iii. A semi-elliptic leaf spring used for automobile suspension consists **6**
          of three extra full-length leaves and 15 graduated-length leaves,
          including the master leaf. The centre-to-centre distance between two
          eyes of the spring is 1 m. The maximum force that can act on the
          spring is 75 kN. For each leaf, the ratio of width to thickness is 9:1.
          The modulus of elasticity of the leaf material is 207 000 N/mm^2.
          The leaves are pre-stressed in such a way that when the force is
          maximum, the stresses induced in all leaves are same and equal to
          450 MPa. Determine
          (a) The width and thickness of the leaves;
          (b) The initial nip; and
          (c) The initial pre-load required to close the gap C between extra
              full-length leaves and graduated-length leaves.

Q.6   Attempt any two:
     i.   Write design procedure of belt drives.   **5**
     ii. Design a chain drive to actuate a compressor from 15 kW electric   **5**
          motor running at 1000 r.p.m., the compressor speed being 350 r.p.m.
          The minimum centre distance is 500 mm. The compressor operates
          16 hours per day. The chain tension may be adjusted by shifting the
          motor on slides.
     iii. Select a wire rope for a vertical mine hoist to lift a load of 55 kN **5**
          from a depth 300 metres. A rope speed of 500 metres / min is to be
          attained in 10 seconds.

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Enrollment No.....................................

Faculty of Engineering
End Sem Examination Dec-2023
AU3CO31 Machine Design

Programme: B.Tech.   Branch/Specialisation: AU

Duration: 3 Hrs.   **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of
Q.1 (MCQs) should be written in full instead of only a, b, c or d. Assume suitable data if
necessary. Notations and symbols have their usual meaning.

Q.1 i.   Notch sensitivity can be reduced by: **1**
           (a) Increasing the size of the notches or defects
           (b) Using a more brittle material
           (c) Improving the surface finish of the material
           (d) Increasing the material's density

     ii.   The Soderberg diagram is particularly useful for analyzing: **1**
           (a) High-cycle fatigue   (b) Low-cycle fatigue
           (c) Creep deformation   (d) Steady-state conditions

     iii. Square keys are typically used for which type of shaft and hub **1**
           connection?
           (a) Sliding fit   (b) Clearance fit
           (c) Interference fit   (d) Transition fit

     iv.   The material of the bushing in a bushed pin flexible coupling is usually **1**
           chosen for its:
           (a) Electrical conductivity
           (b) Corrosion resistance
           (c) Thermal insulation properties
           (d) Wear resistance and damping characteristics

     v.   The torque (T) applied to a shaft is directly proportional to which of **1**
           the following parameters?
           (a) Length of the shaft
           (b) Radius of the shaft
           (c) Shear modulus (G) of the material
           (d) Density of the material

vi. The maximum allowable combined stress for a shaft is often **1** determined by applying a safety factor to the:
(a) Material density
(b) Torsional rigidity of the shaft
(c) Yield strength of the material
(d) Temperature at which the shaft operates

vii. When designing a helical spring, which parameter is used to determine **1** the spring's maximum load-carrying capacity?
(a) Pitch
(b) Modulus of rigidity
(c) Maximum deflection
(d) Ultimate tensile strength of the material

viii. In leaf spring design, the "spring rate" refers to: **1**
(a) The rate at which the leaves bend
(b) The rate of corrosion
(c) The rate of deflection per unit of load
(d) The rate of heat absorption

ix. To increase the power transmission capacity of a belt drive, you can: **1**
(a) Increase the pulley size
(b) Decrease the belt tension
(c) Reduce the number of belts
(d) Lubricate the belt

x. What is the primary advantage of roller chains over flat chains? **1**
(a) Greater flexibility (b) Higher load-carrying capacity
(c) Simplicity of design (d) Lower cost

Q.2 i. Define fluctuating load? **2**

ii. The load on a bolt consists of an axial pull of 10 kN together with a **8** transverse shear force of 5kN. Find the diameter of bolt required according to:
(a) Maximum principal stress theory,
(b) Maximum shear stress theory,
(c) Maximum principal strain theory,
(d) Maximum strain energy theory.

OR iii. A steel rod is subjected to a reversed axial load of 180kN. Find the **8** diameter of the rod for a factor of safety of 2. Neglect column action. The material has an ultimate tensile strength of 1070 MPa and yield strength of 910 MPa. The endurance limit in reversed bending may be

assumed to be one-half of the ultimate tensile strength. Other correction factors may be taken as follows: For axial loading = 0.7, For machined surface = 0.8, For size = 0.85, For stress concentration = 1.0.

Q.3 i. Define keys? Also write their types with neat sketch. **4**

ii. Design and make a neat dimensioned sketch of a muff coupling which **6** is used to connect two steel shafts transmitting 40 kW at 350 r.p.m. The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses may be taken as 40 MPa and 80 MPa respectively. The material for the muff is cast iron for which the allowable shear stress may be assumed as 15 MPa.

OR iii. A 45 mm diameter shaft is made of steel with a yield strength of **6** 400 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with a yield strength of 340 MPa is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety of 2.

Q.4 i. Write the steps to design a shaft subjected to twisting moment. **2**

ii. A shaft is supported on bearings A and B, 800 mm between centers. A **8** 20° straight tooth spur gear having 600 mm pitch diameter, is located 200 mm to the right of the left-hand bearing A, and a 700 mm diameter pulley is mounted 250 mm towards the left of the bearing B. the gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180° angle of wrap. The pulley also serves as a flywheel and weights 2000 N. the maximum belt tension is 3000 N and the tension ratio is 3: 1. Determine the maximum bending moment and the necessary shaft diameter if the allowable shear stress of the material is 40 MPa.

OR iii. A shaft supported at the ends in ball bearings carries a straight tooth **8** spur gear at its mid span and is to transmit 7.5 kW at 300 r.p.m. The pitch circle diameter of the gear is 150 mm. The distances between the centre line of bearings and gear are 100 mm each. If the shaft is made of steel and the allowable shear stress is 45 MPa, determine the diameter of the shaft. Show in a sketch how the gear will be mounted on the shaft; also indicate the ends where the bearings will be mounted? The pressure angle of the gear may be taken as 20°.