Name: **Enrolment No:**	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2023

Program Name: **B. Tech Mechatronics** **Semester:** **V**
Course Name: **Design of Machine Elements** **Time:** **3 hrs**
Course Code: **MECH3024** **Max. Marks:** **100**

Instructions: Assume any missing data if required. Use of design data handbook is permitted.

	SECTION A **(5Qx4M=20Marks)**		
Q.1	Define the term stress concentration and methods of mitigating it.	**4**	**CO1**
Q.2	Discuss the factors to be investigated while selecting a bearing for an application.	**4**	**CO1**
Q.3	Explain the basic governing equation for a power screw which correlates the applied torque with the load to be raised or lowered, angle of friction and helix angle.	**4**	**CO1**
Q.4	Discuss the various types of gear tooth failures.	**4**	**CO1**
Q.5	Discuss design on the basis of strength and design on the basis of rigidity with suitable examples.	**4**	**CO1**
	SECTION B **(4Qx10M= 40 Marks)**		
Q.6	Design a knuckle joint to transmit 150 kN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression.	**10**	**CO1**
Q.7	Explain the terms Endurance limit, fatigue limit and life cycle. Also explain the S-N curve with the help of neat and clean diagram and the salient points on it.	**10**	**CO2**
Q.8	Select a single row deep groove ball bearing for a radial load of 7000 N and an axial load of 8000 N, operating at a speed of 1000 rpm, for an average life of 3 years at 8 hours per day. Assume uniform and steady load. Take the bore diameter as 120 mm.	**10**	**CO2**
Q.9	Design a rigid flange coupling to transmit a torque of 250 N-m between two coaxial shafts. The shaft is made of alloy steel, flanges of cast iron and bolts of steel. The bolts are used to couple the flanges. The shafts are keyed to the flange hub. The permissible stresses are given below: Shear stress on shaft =100 MPa Bearing or crushing stress on shaft =250 MPa Shear stress on keys =100 MPa Bearing stress on keys =250 MPa Shearing stress on cast iron =200 MPa	**10**	**CO2**

	Shear stress on bolts =100 MPa **OR** It is required to design a coupling of flange type for connecting motor and a centrifugal pump, the details of the duty required from coupling are power 18 KW speed 1000 rpm. Find the diameter of the motor & pump shaft. Allowable stress in shaft is 50 N/mm2 and angle of twist is not to exceed 75 degrees, in a length of 20 diameters. The allowable shear stress in coupling bolt is 30 N/mm^2. Assume torsional moment to be transmitted is 20% more than mean torsional moment.		
SECTION-C **(2Qx20M=40 Marks)**			
Q.10	An overhang hollow shaft carries a 900 mm diameter pulley, whose centre is 250 mm from the centre of the nearest bearing. The weight of the pulley is 600 N and the angle of lap is 180°. The pulley is driven by a motor vertically below it. If permissible tension in the belt is 2650 N and if coefficient of friction between the belt and pulley surface is 0.3, estimate, diameters of shaft, when the internal diameter is 0.6 of the external. Neglect centrifugal tension and select a FOS equals to 5. Design the shaft by selecting a suitable material.	**20**	**CO3**
Q.11	A compressor at 300 rpm is driven by a 15 KW 1200 rpm motor, through a 14 ½ full depth gears. The center distance is 0.375 m. The motor pinion is of C 30 forged steel (hardened & tampered) and the driver is of cast steel. Assuming medium shock condition. Design the gear pair. **OR** A pair of 20° full-depth involute tooth spur gears is to transmit 30 kW at a speed of 250 r.p.m. of the pinion. The velocity ratio is 1: 4. The pinion is made of cast steel having an allowable static stress, =100 MPa, while the gear is made of cast iron having allowable static stress = 55 MPa. The pinion has 20 teeth, and its face width is 12.5 times the module. Determine the module, face width and pitch diameters of both the pinion and gear from the standpoint of strength only taking velocity factor into consideration. The tooth form factor is given by the expression Lewis form factor y =0.154 –(0.912/z) & velocity factor is given by=3/(3 +v), where z= no. of teeth and v = peripheral speed of the gear in m/s.	**20**	**CO3**