Enrolment No./Seat No_____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–VII (NEW) EXAMINATION – WINTER 2024

Subject Code:3171917 Date:07-12-2024

Subject Name: Design of Machine Elements

Time:10:30 AM TO 01:30 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**
5. **Use of Design Data Book is allowed.**

Q.1 **(a)** In a gear speed reducer, why is the diameter of an output shaft greater than input shaft? **03**

(b) Explain the manufacturing considerations to take into account while designing the assemblies. **04**

(c) Following data is given for the design of spur gear; **07**

Power to be transmitted by gears = 15 KW at 1500 rpm from the electric motor to a machine shaft.

Tooth system = 20^0 full depth involute

Number of teeth on pinion = 25

Speed reduction ratio = 3:1

Service factor = 1.25

Material of pinion and gear = FG 200 and properties of materials are ultimate tensile stress of 180 N/mm^2, surface hardness of 200 BHN, endurance strength of 84 N/mm^2 and Modulus of elasticity of 1.1 * 10^5 N/mm^2.

Dynamic load factor = 178 N/mm

The gears are manufactured using grade 6 having total error of 0.030 mm.

Velocity factor = 3/ (3 + v)

Design the gear and find out the dimensions of it.

Q.2 **(a)** Explain the stresses acting on the crane hook. **03**

(b) Explain the methods of pre-stressing of the pressure vessels. **04**

(c) Calculate the power transmitting capacity of the rigid coupling having following specifications; **07**

Outer diameter of flanges = 100 mm

Diameter of recess = 95 mm

Number of bolts = 6

Pre-load on each bolt = 10 KN

Coefficient of friction = 0.15

Speed of rotation = 100 rpm.

Draw the neat sketch of rigid coupling.

OR

(c) A concentric spring consist of two helical compression springs having the same free length. The composite spring is subjected to a maximum force of 2000 N. The wire diameter and mean coil diameter of inner spring are 8 mm and 64 mm respectively. Also the wire diameter and mean coil diameter of outer springs are 10 mm and 80 mm respectively. Both the springs are made up of same material having modulus of rigidity of 81370 N/mm^2. **07**

Calculate: (i) the maximum force transmitted by each spring, (ii) the maximum torsional shear stress induced in each spring.

Q.3 **(a)** Explain the guidelines suggested by Mackee's curve with neat sketch for selection of hydrodynamic bearings. **03**

(b) Explain the function of coupling. How it is differ from clutch? **04**

(c) Calculate the power lost in friction and side leakage in the 360^0 journal bearing using following data: Load 50 KN **07**
Journal diameter = 110 mm
Bearing length = 55 mm
Journal speed = 1400 rpm
Minimum oil-film thickness = 15 microns
Viscosity of lubricant = 0.86 cP.

OR

Q.3 **(a)** Explain the objectives of providing openings in pressure vessels. **03**

(b) Explain the causes and remedies of failure of rolling contact bearings. **04**

(c) Find the expected life of the bearing in hours, which is subjected to the following work cycle: **07**

Radial load (KN)	Speed (rpm)	Elemental time (%)
4.45	150	30
6.675	600	10
2.225	300	60

The inner race rotates and the loads are steady. The static and dynamic load capacity of the bearing is 10.013 KN and 14.952 KN respectively.

Q.4 **(a)** Explain with neat sketch force analysis of bevel gears. **03**

(b) Explain the four important parameters required to specify the worm gear drive. **04**

(c) Calculate the power transmitting capacity of a pair of parallel helical gears consists of 20 teeth pinion meshing with a 100 teeth gear. The normal pressure angle is 20^0 and the helix angle is 25^0. The pinion rotates at 720 rpm. The face width is 40 mm and the normal module is 4 mm. The pinion and gear both are made of same material having UTS 600 N/mm^2 and material is heat treated to a surface hardness of 300 BHN. Assume service factor and factor of safety of 1.5 and 2 respectively. **07**

OR

Q.4 **(a)** Explain applications of multi-leaf springs and the objectives of nipping of leaf springs. **03**

(b) Determine the mean diameter of a helical compression spring subjected to an axial force of 3.5 KN. The spring index can be taken as 5. The spring is made of material having UTS of 1050 N/mm^2 and modulus of rigidity of 81370 N/mm^2. **04**

(c) A cylindrical vessel is subjected to an internal pressure of 1.05 MPa. The plate material has yield strength of 200 MPa and a corrosion allowance of 1.5 mm. The joints are spot radiographed double butt type. The vessel inner diameter is to be 2.3 m, determine the thickness of the shell. Assume FOS = 1.5 and joint efficiency = 0.85. **07**
Also find the head thickness if the ends are:
(i) Hemispherical (ii) ellipsoidal with k = 2
(iii) conical with semi-cone angle is 20^0.

Q.5 **(a)** Explain what is the meaning of virtual number of teeth in gears. Write the equations of it in case of helical, bevel gears. **03**

(b) Differentiate between Arithmetic, Geometric and Harmonic progressions in case of design of gear box. **04**

(c) For the design of a 2 x 3 machine tool gear box with following specifications: **07**
Minimum speed = 100 rpm, Maximum speed = 960 rpm. GP ratio = 1.26.
(i) Draw structure diagram (ii) draw ray diagram and speed chart.

OR

Q.5 **(a)** Classify the cranes on the basis of different standards. **03**

(b) Explain the different types of forces acting on a rocker arm in valve gear mechanism of an engine. **04**

(c) A 6 x 19 size wire rope is used to lift a vertical load of 32000 N from 600 m deep mine. The load is being lifted at speed of 12.5 m/s, which is attained in 12 seconds. The required data for design is as given below; **07**

Area of wire rope = $0.38 * d^2$ mm^2

Diameter of wire = $0.063 * d$ mm

Mass of rope per 100 m = $0.36 * d^2$ Kg

Diameter of sheave = $40 * d$

Modulus of elasticity of rope material = $0.84 * 10^5$ MPa

Breaking load = $510 * d^2$ N

Factor of safety = 5

(d is the diameter of rope in mm)

Determine the suitable size of the wire rope.

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