BACHELOR OF TECHNOLOGY (C.B.C.S.) (2014 COURSE)
B.Tech.Sem - VIII MECHANICAL :SUMMER- 2022
SUBJECT : OPTIMUM DESIGN

Day : Monday | Time : 02:30 PM-06:30 PM
Date : 20-06-2022 | **S-13466-2022** | Max. Marks : 60

N.B.:

1) All questions are **COMPULSORY.**
2) Figures to the right indicate **FULL** marks.
3) Assume suitable data if necessary.
4) Non-programmable **CALCULATOR** is allowed.

Q.1 Derive an expression for wear strength of straight bevel gear tooth. **(10)**

OR

Q.1 The hoisting drum is to be driven by a 1440 r.p.m. electric motor through a single stage worm gear reducer. Using following data, design the worm gear pair and select standard electric motor. **(10)**

Capacity of the hoist = 4 kN.
Hoisting speed = 35m/min.
Hoisting drum dia. = 310mm.
Efficiency of hosting arrangement = 92% (Excluding gear reducer).
Ultimate tensile strength for alloy steel worm = 720 N/mm^2
Ultimate tensile strength for phosphor bronze worm gear = 240N/mm^2
Worm gear wear factor = 0.825N/mm^2
Coefficient of friction between worm and worm gear teeth = 0.08
Tooth system = 20^0 full depth involute
Diametral quotient = 12
Application factor = 1.5
Factor of safety = 2.0
Permissible temperature rise for lubricating oil = 55^0C
External surface area of housing = $1.14 \times 10^{-4} \times a^{1.7}$ m^2
Where a = center distance in mm.
Would you recommend a fan or blower for the gear reducer?

Q.2 A 2x2 drive is required for transmitting speeds starting from 400rpm with a geometric progression ratio of 1.4. Draw a suitable structure and speed diagram. Also draw the layout of the gear box and determine the number of teeth on each gear. Assume that a belt drive is used to get the desired speed at input from motor shaft. **(10)**

OR

Q.2 A nine speed sliding mesh gearbox based on R_5 is to be designed for the speeds starting from 200rpm. It is to be driven a three-phase induction motor running at 1480rpm. List out all speeds for the proposed system. Write all structure formulae. Draw symmetric structure diagrams. Select optimum structure diagram. Draw speed diagram. Assuming minimum number of teeth on the smallest gear in each stage on as 20, Find out number of teeth on each gear. Also find out the actual speeds and hence plot deviation diagram. **(10)**

$R_5 = \sqrt[5]{10} = 1.5848$

Q.3 A machine member made of plain carbon steel has mean yield strength of 250MPa and standard deviation of 32 MPa. This member is subjected to a bending stress with a mean of 165 MPa and standard deviation of 18 MPa. Determine: **(10)**

i) Probability of failure and reliability of the machine member
ii) The minimum factor of safety available
iii) The average factor of safety available

Assume normal distribution.

Z	1.6	1.7	1.8	1.9	2.0	2.1	2.2
Area	0.4452	0.4554	0.4642	0.4821	0.4861	0.4893	0.4918

P.T.O.

OR

Q.3 Three cylindrical components each with a length of 30mm are to be assembled to give a total length of 90 ± 0.6mm. All individual cylindrical components have same standard deviation and their natural and design tolerances are equal. Specify the tolerance for individual components. **(10)**

Q.4 A closed vessel having internal diameter of 430mm is to be designed to with stand an internal pressure of 45 MPa. The material to be used is ductile with Syt = 300 MPa, S_{ut} = 500 MPa and Poisson's ratio = 0.3, Estimate the wall thickness by using factor of safety 1.5. So designed cylinder if over loaded above the designed pressure, what will be the magnitude of pressure at which the cylinder will actually fail? **(10)**

OR

Q.4 A cylindrical shell has an internal diameter of 2.5m and is made of plain carbon steel with yield strength of 200MPa. Double welded butt it joints which are spot radiographed are used to fabricate the shell. Torispherical heads with a crown radius of 2m knuckle radius of 120mm are used as end closures. Operating pressure inside the shell is 0.75MPa corrosion allowance is 3mm. Determine the thickness of cylindrical shell and Torispherical head. (η_l = 0.85). **(10)**

Q.5 Design a tensile bar of length 300mm to carry a tensile load of 6 kN for minimum cost out of the following material. **(10)**

Material	Density (ρ) Kg/m^3	Cost (₹/N)	Yield strength (MPa)
Steel	8000	32	130
Al Alloy	4000	64	50
Ti Alloy	6000	600	90
Mg Alloy	3100	64	20

OR

Q.5 A beam of rectangular cross section is subjected to a maximum bending moment M and maximum shear force V. The allowable stresses in bending and shear are σ_A and τ_A respectively. The bending stress is given by $\sigma = \frac{6M}{bd^2}$ and the average shear stress is given by $\tau = \frac{3V}{2bd}$, where 'b' and'd' are width and depth of the cross section. Design for optimization for minimum cross sectional area using following data. **(10)**

M = 40 kN-m, V= 150 kN, σ_A= 10 MPa, τ_A = 2 MPa.

Determine the range of optimum dimensions for the cross section of beam.

Q.6 **a)** Explain the design considerations for design of forgings. **(05)**

b) Explain the basic principles of DFMA. **(05)**

OR

Q.6 What are the legal and ethical issues in design? Explain in detail. **(10)**

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