GANPAT UNIVERSITY

B. Tech. VII Sem. Mechanical Engineering

CBCS Regular Examination NOV 2014

2ME702 - Design of Mechanical Systems

[Time: 3 Hour] [Total Marks: 70]

Instructions:

(1) Attempt all questions.
(2) Assume suitable data if necessary.
(3) Figures to the right indicate full marks
(4) Only scientific calculator is allowed.
(5) Design data book is not allowed.

SECTION - I

Que: 1 Attempt the followings.

(a) Explain factors to be considered for selection of material handling equipment. [4]

(b) Explain the Howser laid rope and cable laid rope with suitable sketch. [4]

(c) A wire rope used to lift the cage of a vertical mine hoist 400 m deep is 6 × 19. The weight of cage is 1200 kg and it has to lift 3000 kg of ore at a speed of 15 m/s which is to be attained in 10 seconds. Take $D_{min}/d = 75$. Assume factor of safety of 5 and $E = 8 \times 10^4$ N/mm^2. Weight of rope/metre = $0.0034d^2$ kg. Cross-sectional area of rope = $0.38d^2$. Ultimate stress for rope wire is 1800 N/mm^2. Determine diameter of rope. Take wire diameter as 0.0063d m. [4]

OR

Que: 1

(a) Explain following: [4]
(i) Fatigue life of rope with suitable graph.
(ii) Stresses in hoisting rope.

(b) Design the pulleys and drum required for an overhead traveling crane with a rope diameter of 16 mm. Take Lifting height = 8 m, Breaking strength per rope = 127×10^3 N, Limiting value of normal stress and combined equivalent stress = 110 N/mm^2, Limiting value of bending stress = 80 N/mm^2, Permissible shear stress = 42 N/mm^2, Free space between drum = 100 mm, Permissible crushing stress = 80 N/mm^2, Total effort required to raise the load = 18640 N, Advisable sheave diameter is 27d. Refer fig.1. [8]

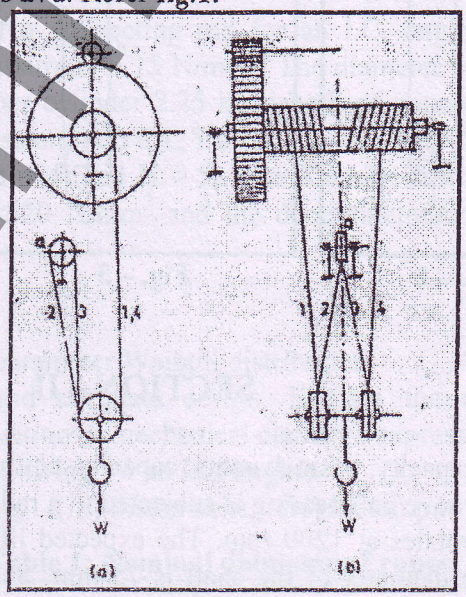

Fig.-1

Que. 2

(a) Draw the FBD of a spur gear pair and derive the relation for the various force acting on them. [4]

(b) A pair of parallel helical gears consisting of a 20 teeth pinion meshing with a 100 teeth gear. [8]
The pinion rotates at 720 rpm. The normal pressure angle is 20°, while the helix angle is 25°. The face width is 40 m and the normal module is 4 mm. The pinion as well as gear are made of steel 40C8 (S_{ut} = 600MPa) and heat treated to a surface hardness of 300 BHN. The service factor and the factor of safety are 1.5 and 2 respectively. Assume that the velocity factor accounts for the dynamic load and calculate the power transmitting capacity of the gears.

OR

Que. 2

(a) Derive a relationship for the wear strength of a helical gear pair. [4]

(b) A pinion having 20 teeth is to mesh with a gear having 43 teeth. The pinion is made of carbon steel having a tensile strength of 600 MPa and the steel gear material has tensile strength of 400 MPa. The pinion is driven by a reversible three phase motor having a working speed of 1440 rpm and 10 kW rating. Starting torque of the motor is twice the working torque. The gear drives a rolling mill. For the standard 20° full depth involute gears, evaluate module and specify the major dimensions of the gears. Specify the hardness of the gears. Pitch line velocity is 5 m/s, face width is 10 times module. [8]

Que. 3

(a) A steel spindle transmits 4 kW at 800 rpm. The angular deflection should not exceed 0.25° per metre of spindle. If the modulus of rigidity for the material of the spindle is 84 GPa, find the diameter of the spindle and the shear stress induced in the shaft. [4]

(b) Explain the interference and under cutting with respect to the gear design. [4]

(c) Count the number of bends for the following systems of **fig. -2, 3 and 4.** [3]

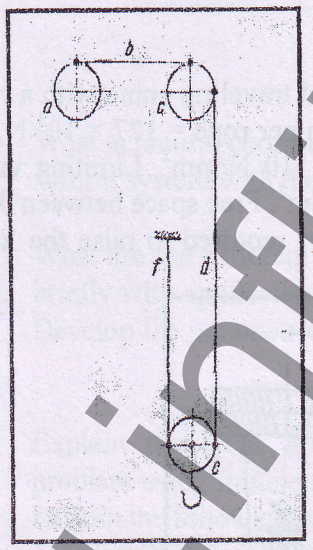

Fig. – 2

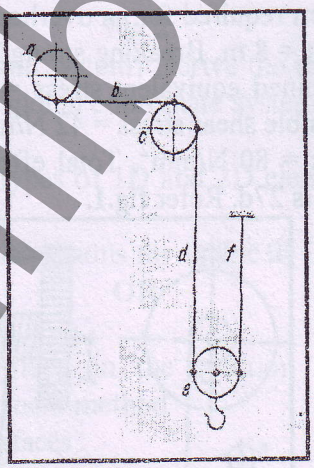

Fig. – 3

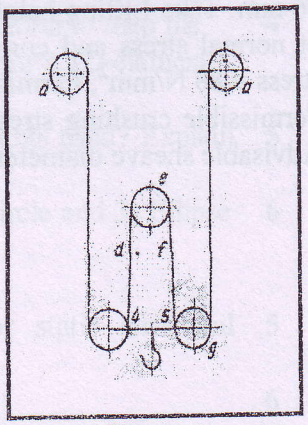

Fig. – 4

SECTION – II

Que:4 **Attempt following.**

(a) Explain basic static capacity, basic dynamic capacity, equivalent dynamic load and rating life. [4]

(b) A single row deep groove ball bearing is subjected to a radial force of 8 kN and as thrust force of 3 kN. The shaft rotates at 1200 rpm. The expected life of the bearing is 20000 hrs. The minimum acceptable diameter of the shaft is 75 mm. Select a suitable ball bearing for this application. [8]

OR

Que:4

(a) Derive the equation of equivalent dynamic load for bearing under cyclic loads with neat sketch. [4]

(b) A single-row deep-groove ball bearing is subjected to the following work cycle: [8]

Element No.	Element Time %	Radial Load 'Fr' KN	Thrust Load 'Fa' KN	Radial Factor 'X'	Thrust Factor 'Y'	Race rotating	Service Factor	Speed R.P.M
1	55	3.0	1.0	0.56	1.4	Inner	1.5	730
2	25	2.5	1.0	0.56	1.6	Outer	2.0	1440
3	Remaining	No Load	No Load	----	----	Outer	----	730

If the expected life of the bearing is 16000 hours with a reliability of 95%, calculate the basic dynamic load rating of the bearing so that it can be selected from the manufacturer's catalogue based on 90% reliability.

If there are six such bearing in the system, what is the probability that all bearings will survive for 16000 hours?

Que.5 Attempt following.

(a) Explain the construction of different types of cylinder liners. Write the qualities of a good liner and enlist liner materials. [3]

(b) Design a piston head, made of cast iron, for a single acting four stroke engine for the following specifications: [8]

Cylinder bore = 100 mm, stroke = 120 mm, maximum gas pressure = 5 N/mm^2, Brake mean effective pressure = 0.65 N/mm^2, fuel consumption = 0.227 kg/KW/hr, speed = 2200 rev/min, allowable tangential stress for C.I. = 37.5 N/mm^2, HCV of the fuel may be taken as 41870 KJ/kg, Take k = 46.6 and (T_c - T_e) = 220°C for C.I. and C = constant representing that portion of the heat supplied to the engine which is absorbed by the piston, approximately 0.05. Only find the thickness of the piston head on the basis of strength and on the basis of heat dissipation through the piston head.

OR

Que.5

(a) Enlist the main functions of the piston. Explain the construction of trunk type piston with neat sketch. [3]

(b) Design only I - section of a connecting rod for an I.C. engine running at 1800 rpm and developing a maximum pressure of 3.15 N/mm^2. The diameter of the piston is 100 mm, mass of the reciprocating parts per cylinder 2.25 kg, length of connecting rod 380 mm, stroke of piston 190 mm and compression ratio 6:1. Take factor of safety of 6 for the design. The rod is to be I-section for which B = 4t and H = 5t. Use Rankine formula for which the numerator constant may be taken as 320 N/mm^2 and the denominator constant 1/7500. Draw a neat dimensional sketch. [8]

Que:6 Attempt following. [12]

(a) Explain 3 parameter and 2 parameter Weibull distribution.

(b) Define optimum design and adequate design. Explain the three parameters which are considered in the design equation of mechanical elements express functional requirements.

(c) State the functions of the following for an I.C. engine.

(i) Ribs, (ii) Piston ring, (iii) Piston skirt, (iv) Piston pin

Table 1: Nominal diameter of ropes

Size or Nominal Dia. (mm)	19	22	25	28	32	38	44	50
Ultimate tensile breaking load (N)	10340	15270	19640	24630	32170	45370	60830	78550

Table – 2: Dimensions of groove

Rope dia. d	Standard			Deep groove		
	r_1	s_1	c_1	s_2	c_2	r_2
4.8	3.5	7	2	9	4.5	5.5
6.2	4.0	8	2	11	5.5	7.0
8.7	5.0	11	3	13	6.5	8.0
11	7.0	13	3	17	8.5	10.0
13	8.0	15	4	19	9.5	11
16	9.0	17	5	22	11	13
19.5	11.5	22	5	27	13.5	16.5
24	13.5	27	6	31	16	18.5
28	15.5	31	8	36	18	20.5
34.5	19	38	10	41	22	25
39	21	42	12	50	24.5	28

Table - 3: Radial and thrust factors for single row deep groove ball bearing

F_a/C_0	F_a/C_0		$(F_a/VF_r) \geq e$		e
	X	Y	X	Y	
0.025	1	0	0.56	2.0	0.22
0.04	1	0	0.56	1.8	0.24
0.07	1	0	0.56	1.6	0.27
0.13	1	0	0.56	1.4	0.31
0.25	1	0	0.56	1.2	0.37
0.5	1	0	0.56	1.0	0.44

Table - 4 : Basic capacities of single row deep groove ball bearings

Bearing number	Static capacity in KN	Dynamic capacity in KN
6014	31.00	37.70
6214	45.00	60.50
6314	68.00	104.00
6414	104.00	143.00
6015	33.50	39.70
6215	49.00	66.30
6315	76.50	112.00
6415	114.00	153.00

END OF PAPER