Kafrelsheikh University
Faculty of Engineering
Department of Mech. Eng.
2ed year Mechanical Engineering
Dr. Ibrahem Maher Soltan

Date: 28 – 5 - 2018
Time allowed: 4 hours
Full Mark: 120
Final year Exam, 2 pages
Course code: **MDP2008**

Machine Design
تصميم الآلات

This exam measures the following ILOs: a1, a3, a4, a5, a8, a16, a19, b1, b2, b3, b4, b5, b6, b7, b9, b13, b14, b15, c1, c2, c3, c4, and c13

Question 1 **(60 Marks)**

1 – A machine member is frequently made with a circular base fastened by "n" equally spaced bolts located on a pitch circle, as shown in Fig. 2. The load on a bolt located at an angle α is given by;

$$P_\alpha = 2PL(R-r\cos\alpha) / (2R^2 + r^2)\, n$$

Find the maximum value of the load Pα. Determine the angle α in order to have the least maximum load on the bolts which are equally spaced.

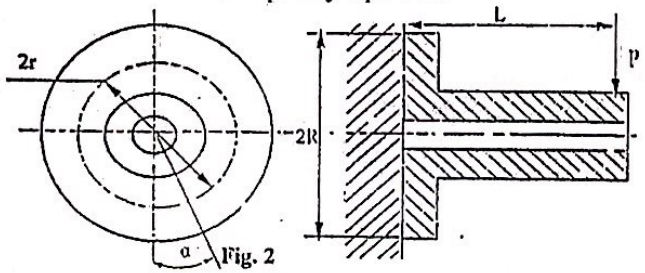

Fig. 2

2 – Figure 4 shows a method of locking threaded joints. Make constructional drawings to show another 3 different methods of locking.

3 – Figure 5 shows a hand wheel fixed to a spindle. Make constructional drawings to show another 3 different versions for this joint.

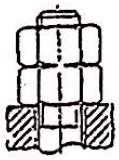
Fig. 4

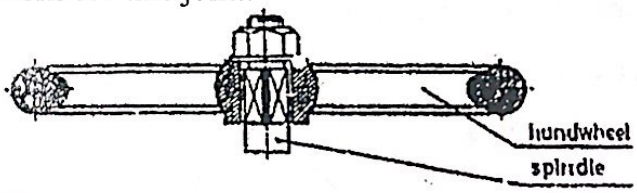

Fig. 5

4 – Make constructional drawing to show 3 different methods for eliminating the effect of shear forces on bolts in threaded joints.

5 – Make a constructional drawing to show 3 different types of key joints.

6 – A 150 mm diameter steel shaft is to have a press fit H7/p6 with a 300 mm outer diameter by 250 mm long hub. The modulus of elasticity of steel E = 200 GPa and the coefficient of friction between the shaft and hub is μ = 0.12. The contact pressure may be calculated by the following equation;

$$Pc = \frac{\delta E(d_o^2 - d_c^2)}{2d_c d_o^2}, \qquad \tau_{all} = 950 \text{ kg/cm}^2$$

a) Determine the minimum and maximum diametral interference.
b) What axial force will be required to press the hub on the shaft?
c) What torque may be transmitted with this fit?
d) If the hub is to be welded from both sides to the shaft, find the size of weld to transmit the same torque transmitted with the press fit.

With my best wishes

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Question 2 **(60 Marks)**

The overhead gear of an electric lift is shown in Fig. 6. The sheave is mounted and keyed centrally on the shaft, which is supported on bearings at 500 mm centers. A steel wire rope passes from the cage over the sheave to the balance mass. The masses of the cage, the maximum load carried by the cage, and the balance mass are 1100, 900, and 1550 respectively. The maximum acceleration of the cage is 2 m/s^2. Assume the shaft to be simply supported at the center of the bearings and driven from the outside left-hand bearing by protected rigid flange coupling which connects the shaft to a gear reducer.

Required;

1 – Select the suitable wire rope, the recommended factor of safety of wire rope. For such application, is 5 based on its breaking strength.

2 – Calculate the shaft diameter, the coupling dimensions, and the key size.

3 – Make a complete constructional drawing of the shaft and mounting on it sheave and coupling. Take τ_{all} = 42MPa for shaft and key, G = 80 GPa, Building tall L = 30 m.

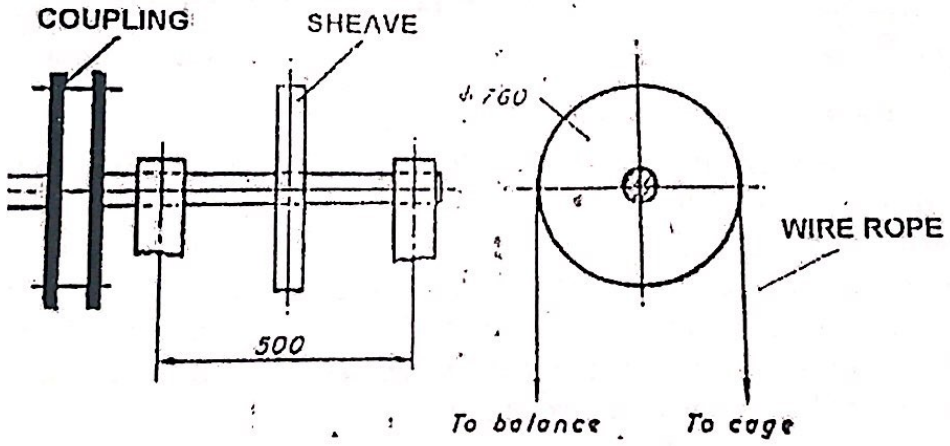

Fig. 6

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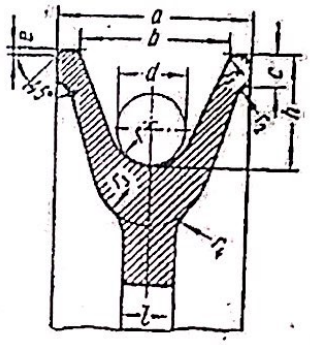
WIRE ROPE DATA

Rope	Nature	Approx. value of Young's modulus, kg/cm²	Min. sheave diameter, (cm)	Weight kg/m (approx.)	Dia. of wire, cm	Area of wires in rope, cm² (approx.)	Breaking load, kg	Use	Remarks
6×7	Coarse	0.9×10^6	$42d$	$0.34d^2$	$0.106d$	$0.38d^2$	$4{,}800d^2$	Mine Haulage, factory yard, inclined planes, tramways, power transmission, gaywires.	Heavy, provides maximum resistance to abrasion and wear.
6×19	Flexible	0.8×10^6	$30d$	$0.37d^2$	$0.063d$	$0.38d^2$	$5{,}100d^2$	Mine hoists, quarries, ore docks, cargo hoists, car pullers, cranes, derricks, dredges, tramways, welldrilling and elevators.	Compromises the flexibility and wear resistance and is most commonly used.
6×37	Extra flexible	0.74×10^6	$18d$	$0.35d^2$	$0.045d$	$0.38d^2$	$4{,}800d^2$	Steel mill ladles, cranes, high speed elevators, service where sheave diameters are limited.	Used where abrasion is not severe and relatively sharp bends must be tolerated.
8×19	Flexible	0.67×10^6	$21d$	$0.346d^2$	$0.050d$	$0.35d^2$	$4{,}400d^2$	Hoists.	

where d is diameter of rope in cm.

It is interesting to note that strength of wire ropes is about 83 percent of the combined strength of all wires in a rope. This is due to unequal sharing of load as inner wires are loaded heavily (being shorter) as compared to outer wires.

Grooves of Sheaves for Steel Wire Ropes, mm



Rope dia	a	b	c	e	h	l	r	r_1	r_2	r_3	r_4
4.8	22	15	5	0.5	12.5	8	4.0	2.5	2.0	8	6
6.2	22	15	5	0.5	12.5	8	4.0	2.5	2.0	8	6
8.7	28	20	6	1.0	15.0	8	5.0	3.0	2.5	9	6
11.0	40	30	7	1.0	25.0	10	8.5	4.0	3.0	12	8
13.0	40	30	7	1.0	25.0	10	8.5	4.0	3.0	12	8
15.0	40	30	7	1.0	25.0	10	8.5	4.0	3.0	12	8
19.5	55	40	10	1.5	30.0	15	12.0	5.0	5.0	17	10
24.0	65	50	10	1.5	37.5	18	14.5	5.0	5.0	20	15
28.0	80	60	12	2.0	45.0	20	17.0	6.0	7.0	25	15
34.5	90	70	15	2.0	55.0	22	20.0	7.0	8.0	28	20
39.0	110	85	18	2.9	65.0	22	25.0	9.0	10.0	40	30

With my best wishes