# TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

**UNIVERSITY EXAMINATION FOR:**

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2413: MACHINE DESIGN

END OF SEMESTER EXAMINATION

**SERIES:** DECEMBER 2016

**TIME:** 2 HOURS

**DATE:** Pick Date Dec 2016

**Instructions to Candidates**

You should have the following for this examination

*-Answer Booklet, examination pass and student ID Pocket Calculator*

This paper consists of **FIVE** questions. Attempt question ONE **(Compulsory)** and any other **TWO** questions.

**Do not write on the question paper.**

**Question ONE(a)**

i) Explain the functions of packings, gaskets and seals as machine elements. (4 marks)

ii). Discuss the strength of a transverse fillet weld (7 marks)

**b)** Explain the procedure for selecting a bearing to withstand radial load only. **(9 marks)**

**c)** A single plate clutch, effective on both sides, is required to transmit 25kW at 3000 rpm. Determine the outer and inner diameters of frictional surface if the coefficient of friction is 0.255, ratio of diameters is 1.25 and the maximum pressure is not to exceed is $0.1N/mm^2$. Also, determine the axial thrust to be provided by springs. Assume the theory of uniform wear and uniform pressure.

**(10 marks)**

**Question TWO**

a) Given the torque transmitted by shaft II in Fig 3(a) is $T_2$=1.738kNm. The analysis of the loads and reactions on the shaft is given below and the preselected bearings on the supports:

$\alpha = 20°\ \ F_{t1} = 13770N;\ \ F_{t2} = 31600N\ \ F_{r1} = 5011N;\ \ F_{r1} = 11500N\ \ F_{tA} = 82N; F_{tB} = 17920\ N; F_{rA} = 30\ N\ F_{rB} = 6521\ N$

Taking service factor for both bearings as 1.05 and n=620 $min^{-1}$

| Bearing No. | d (mm) | D (mm) | C (kN) | $C_0$ (kN) | $k_T$ | $k_b$ | V | X | Y |
|---|---|---|---|---|---|---|---|---|---|
| Radial bearing 212 | 60 | 110 | 52000 | 31000 | 1 | 1.3 | 1.2 | 1 | 2.3 |
| Roller bearings 32312 | 60 | 130 | 123000 | 76500 | 1 | 1 | 1 | 1 | 2.9 |

i) Draw the diagrams for the horizontal, vertical, combined and equivalent moments on the shaft.

ii) The viability of life for the preselected bearings. (20 marks)

**Question THREE**

a) Fig 3a) is a schematic design of a helicopter transmission system. Design the shafts *I, II* & *III* in the schematic diagram given the following parameters:

$T_I = 546kNm\ \ \frac{d}{D} = 0.85,\ \tau_{\max} = 80MPa\ , T_{II} = 0.8T_I\ , T_{III} = 0.87T_{II}$ Assume no loss on power transmission.

**(6 marks)**

b) Given the nominal diameter of the gear for is d=77.5mm, the pressure angle α=20° for the gear teeth and the length of the shaft for the shaft design as a beam is given in Fig 3(b) for the shaft I,

i) find the reactions at the bearing support A & B.

ii) Draw the horizontal, vertical, combined and equivalent bending moments of the shaft I.

**(14 marks)**

**Question FOUR**

b) Sketch out and design a clamp coupling to transmit 80 kW at 150 rpm. The allowable shear stress for the shaft and key is 40 MPa and the number of bolts connecting the two halves are six. The permissible tensile stress for the bolts is 70MPa. The coefficient of friction between the muff and the shaft surface may be taken as 0.3 **(20 marks)**

**Question FIVE**

a) Discuss in detail the complete design procedure of a shaft. (14 marks)

b) Mention 6 design requirements for a good shaft coupling. (6 marks)

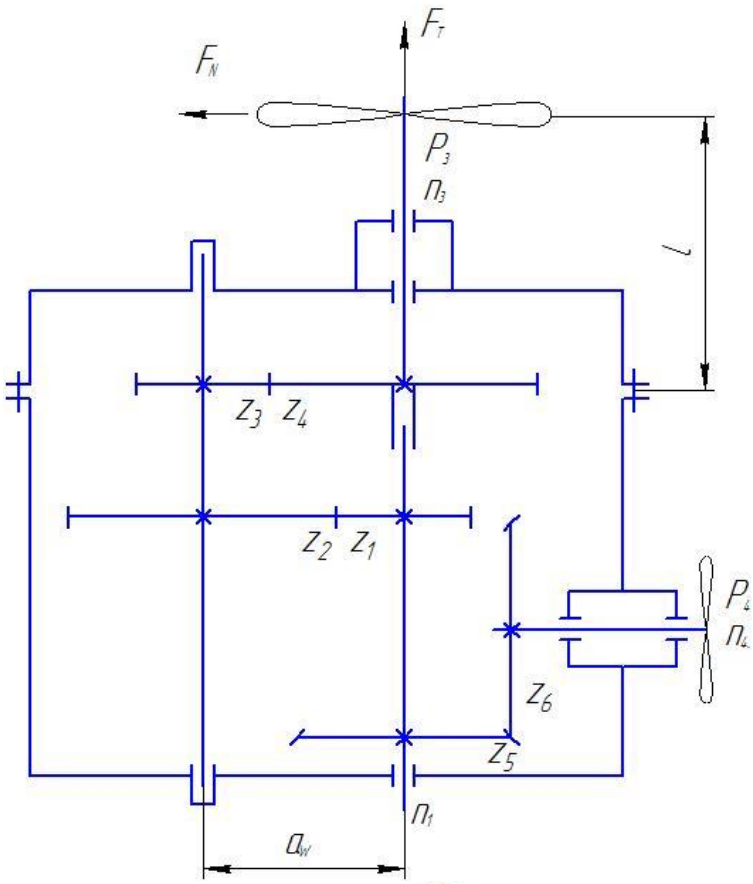


Fig 3(a)

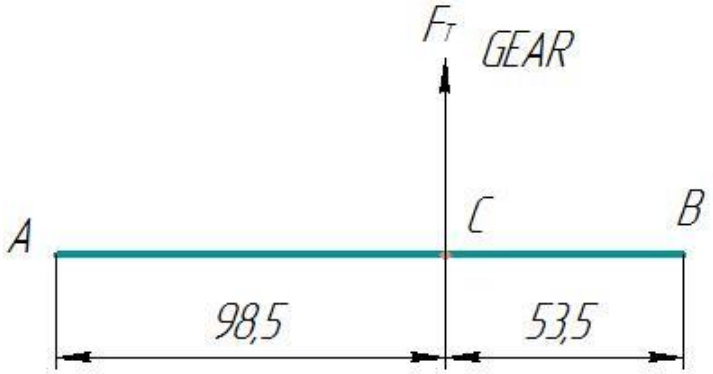


Fig 3(b)

**Table for key dimensions in relation to shaft size.**

| Shaft diameter & upto (mm) | Key Width (mm) | Key thickness (mm) |
|---|---|---|
| 58 | 18 | 11 |
| 65 | 20 | 12 |
| 75 | 22 | 14 |
| 85 | 25 | 14 |
| 95 | 28 | 16 |
| 110 | 32 | 18 |
| 130 | 36 | 20 |
| 150 | 40 | 22 |
| 170 | 45 | 25 |
| 200 | 50 | 28 |
| 230 | 56 | 32 |
| 260 | 63 | 32 |
| 290 | 70 | 36 |
| 330 | 80 | 40 |
| 380 | 90 | 45 |
| 440 | 100 | 50 |

**Standard Metric Bolt Table**

| Nominal size and thread diameter | Pitch of thread (coarse pitch series) | Width across flats | | Height of head | | Tapping drill | Clearance drill |
|---|---|---|---|---|---|---|---|
| | | (max) | (min) | (max) | (min) | | |
| M1.6 | 0.35 | 3.2 | 3.08 | 1.225 | 0.975 | 1.25 | 1.65 |
| M2 | 0.4 | 4.0 | 3.88 | 1.525 | 1.275 | 1.60 | 2.05 |
| M2.5 | 0.45 | 5.0 | 4.88 | 1.825 | 1.575 | 2.05 | 2.60 |
| M3 | 0.5 | 5.5 | 5.38 | 2.125 | 1.875 | 2.50 | 3.10 |
| M4 | 0.7 | 7.0 | 6.85 | 2.925 | 2.675 | 3.30 | 4.10 |
| M5 | 0.8 | 8.0 | 7.85 | 3.650 | 3.35 | 4.20 | 5.10 |
| M6 | 1 | 10.0 | 9.78 | 4.15 | 3.85 | 5.00 | 6.10 |
| M8 | 1.25 | 13.0 | 12.73 | 5.65 | 5.35 | 6.80 | 8.20 |
| M10 | 1.5 | 17.0 | 16.73 | 7.18 | 6.82 | 8.50 | 10.20 |
| M12 | 1.75 | 19.0 | 18.67 | 8.18 | 7.82 | 10.20 | 12.20 |
| M14 | 2 | 22.0 | 21.67 | 9.18 | 8.82 | 12.00 | 14.25 |
| M16 | 2 | 24.0 | 23.67 | 10.18 | 9.82 | 14.00 | 16.25 |
| M18 | 2.5 | 27.0 | 26.67 | 12.215 | 11.785 | 15.50 | 18.25 |
| M20 | 2.5 | 30.0 | 29.67 | 13.215 | 12.785 | 17.50 | 20.25 |
| M22 | 2.5 | 32.0 | 31.61 | 14.215 | 13.785 | 19.50 | 22.25 |
| M24 | 3 | 36.0 | 35.38 | 15.215 | 14.785 | 21.00 | 24.25 |
| M27 | 3 | 41.0 | 40.38 | 17.215 | 16.785 | 24.00 | 27.25 |
| M30 | 3.5 | 46.0 | 45.38 | 19.26 | 18.74 | 26.50 | 30.50 |
| M33 | 3.5 | 50.0 | 49.38 | 21.26 | 20.74 | 29.50 | 33.50 |
| M36 | 4 | 55.0 | 54.26 | 23.26 | 22.74 | 32.00 | 36.50 |
| M39 | 4 | 60.0 | 59.26 | 25.26 | 24.74 | 35.00 | 39.50 |
| M42 | 4.5 | 65.0 | 64.26 | 26.26 | 25.74 | 37.50 | 42.50 |
| M45 | 4.5 | 70.0 | 69.26 | 28.26 | 27.74 | 40.50 | 45.50 |
| M48 | 5 | 75.0 | 74.26 | 30.26 | 29.74 | 43.00 | 48.75 |
| M52 | 5 | 80.0 | 79.26 | 33.31 | 32.69 | 47.00 | 52.75 |
| M56 | 5.5 | 85.0 | 84.13 | 35.31 | 34.69 | 50.50 | 56.75 |
| M60 | 5.5 | 90.0 | 89.13 | 38.31 | 37.69 | 54.50 | 60.75 |
| M64 | 6 | 95.0 | 94.13 | 40.31 | 39.69 | 58.00 | 64.75 |
| M68 | 6 | 100.0 | 99.13 | 43.31 | 42.96 | 62.00 | 68.75 |