TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

UNIVERSITY SPECIAL/SUPPLEMENTARY EXAMINATION FOR:

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

EMG 2413: MACHINE DESIGN

SERIES: SEPT 2017

TIME: 2 HOURS

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). Discuss the advantages of roller bearings over sliding bearing **(7marks)**

ii. A catalog lists the basic dynamic load rating for a ball bearing to be 35000N for a rated life of 10^6 revolutions. What would be the expected L_{10} life of the bearing if it were subjected to 15000N and determine the life in hours that this corresponds to if the speed of rotation is 2000 rpm. Comment on its suitability for a machine. **(4 marks)**

b) Give the criteria used that determine the selection of a packing **(5 marks)**

c) Give the specifications required for the design of fully hydrodynamic lubricated bearings. (**6 marks)**

d) Sketch out the design of an unprotected type flange coupling **(8 marks)**

Question TWO

a) A shaft at the ends in ball bearings carries a straight tooth spur gear at its mid span and is to transmit 7.5kW at 300 rpm. The pitch circle diameter of the gear is 150mm. The distance between the center line of bearings and gear are 100mm each. If the shaft is made of steel and the allowable stress is 45MPa. The pressure angle of the gear may be taken as 20°. Determine:

i. the diameter of the shaft

ii. Sketch out how the gear will be mounted on the shaft **(14 marks)**

b) Give advantages of welded joints over riveted joints **(6 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:

$T_I = 546kNm \quad \frac{d}{D} = 0.85, \ \tau_{\max} = 80MPa \ , T_{II} = 0.7T_I \ , T_{III} = 0.87T_{II} \ T_{life} = 1000hrs$ **(6 marks)**

b) b) Given T_2=1.738kNm the pitch diameter of the gears for is d=252.5mm & d=110mm respectively, the pressure angle α=20° for both gears and the length of the shaft for the shaft design as a beam is given in Fig 3(b) for the shaft II,

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

ii) Draw the horizontal, vertical, combined and equivalent bending moments of the shaft II **(14 marks)**

Question FOUR

a) Demonstrate with illustration and the failures of a riveted joint. **(5marks)**

b) A 20kW, 800 rpm motor has a mild steel shaft of 40mm diameter and the extension being 75 mm. The permissible shear and crushing stresses for the mild steel key are 50MPa and 110MPa. Design the keyway in the motor shaft extension. Check the shear strength of the square key against the normal strength of the shaft. Take least key width dimension to be 0.25 of shaft diameter. **(15 marks)**

Question FIVE

a) Explain the regimes of lubrication of sliding bearings and the relationship with the coefficient of friction. **(7 marks)**

b) A clutch is required for transmission of power between a four-cylinder internal combustion engine and a small machine. Determine the radial dimensions for a single face dry disc clutch with a molded lining which transmit 15 kW at 2000 rpm, Base the design on the uniform wear assumption.

Take service factor of 2. Coefficient of friction molded lining μ=0.35 (8marks)

c) With the help of a diagram derive maximum shear stress for a long fillet weld subjected to torsion. (5 marks)

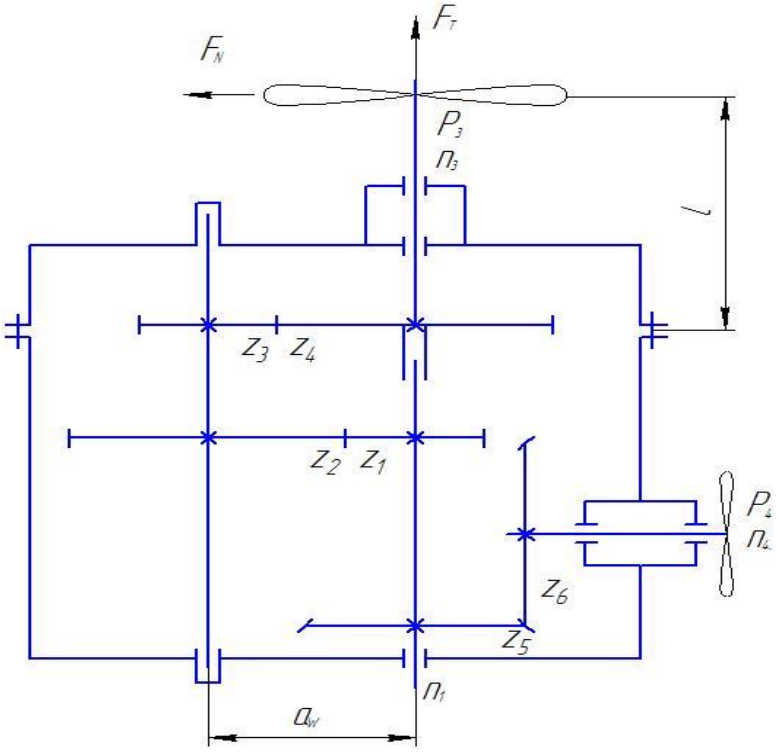

Fig 2(a)

Fig 2(b)

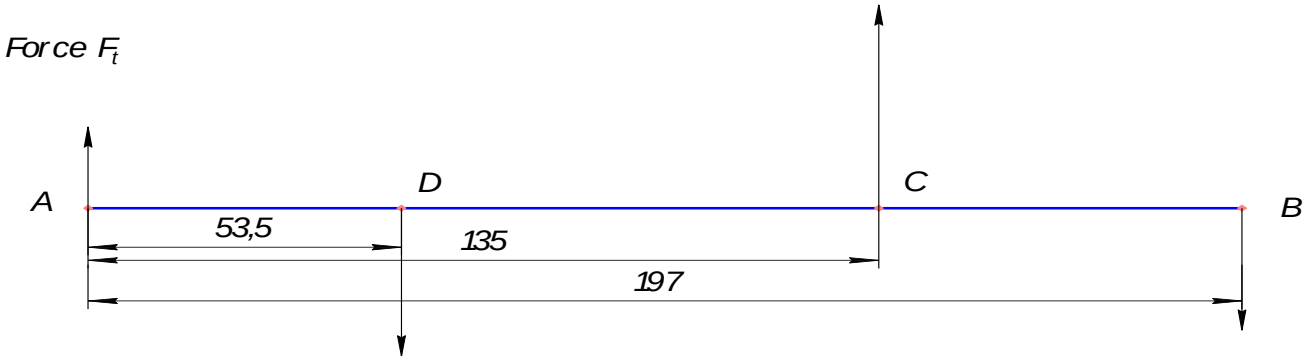

Fig 3(b)

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

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

Material	Maximum load capacity P (MN/m^2)	Limiting PV value ($MN/m\,s$)	Maximum operating temperature (°C)	Coefficient of friction	Coefficient of expansion ($\times 10^{-6}$/°C)
Carbon/graphite	1.4–2	0.11	350–500	0.1–0.25 dry	2.5–5.0
Carbon/graphite with metal	3.4	0.145	130–350	0.1–0.35 dry	4.2–5
Graphite impregnated metal	70	0.28–0.35	350–600	0.1–0.15 dry	12–13
Graphite/ thermosetting resin	2	0.35	250	0.13–0.5 dry	3.5–5
Reinforced thermosetting plastics	35	0.35	200	0.1–0.4 dry	25–80
Thermoplastic material without filler	10	0.035	100	0.1–0.45 dry	100
Thermoplastic with filler or metal backed	10–14	0.035–0.11	100	0.15–0.4 dry	80–100
Thermoplastic material with filler bonded to metal back	140	0.35	105	0.2–0.35 dry	27
Filled PTFE	7	Up to 0.35	250	0.05–0.35 dry	60–80
PTFE with filler, bonded to steel backing	140	Up to 1.75	280	0.05–0.3 dry	20
Woven PTFE reinforced and bonded to metal backing	420	Up to 1.6	250	0.03–0.3	–