City University London

Term 2 Assessment, 2004/2005

School of Engineering and Mathematical Sciences

ME1105 Engineering Drawing & Design

SOLUTIONS

Student Name:……, Group: ……

Max. No of Marks: **30**

Examination duration: 1 hour
Reading time: 5 minutes
This paper has: 5 pages

Authorized materials:

Electronic calculators and drawing instruments may be used.

Instructions to invigilators: Candidates are to complete the examination by writing and drawing **in this examination paper**, which must be collected at the end of the examination. The data required for solutions are attached to this paper. Therefore, no additional script books should be required.

Instructions to students:

Attempt **all** of the three questions. All questions are of equal value.

Space is provided **in this paper** to complete all the questions. No additional script books should be required. The whole paper must be left for collection by the invigilators at the end of the examination.

DO NOT DETACH PAGES FROM THIS PAPER!

REMEMBER: WRITE YOUR NAME AND GROUP in the provided space.!

Q1: **10 marks**
Each correct answer 0.4 marks

Question 1

Indicate whether the following statements are **T**rue or **F**alse by **ticking** the appropriate selection box.

T	F	
	X	Three groups of engineering design constraints are physical, sociological and practical.
X		Check off list and brainstorming are methods of making alternative solutions
	X	During the analysis of alternative solutions common sense is more important then the consideration of laws of nature and laws of economics
X		The isolated system together with all forces and moments due to external effects and the reactions with the main system is called free-body diagram.
	X	Strength is a state property of a body which is a function of load, geometry, temperature and manufacturing processing
X		Strength, rigidity, wear resistance, heat resistance and resistance to vibrations are considerations or criteria to be addressed during mechanical design
X		A static load is a stationary force or moment acting on a member unchanged in magnitude, point of application and direction.
	X	In the factor of safety method, distributions of stresses and strengths are obtained and related in order to achieve an acceptable success rate.
	X	Factor of safety relates strength and stress as: $N = Stress/Strength = \sigma/S$
	X	M12x1.75 means: Metric thread 12 mm diameter, 1.75 mm long
X		Only first six threads in the threaded connection take tensile load
X		Power screws usually have square or ACME threads.
	X	¼ in-20 UNRC is the nomination for unified fine thread on ¼ inch diameter
X		Main components of a roller bearing are: outer and inner rings, rollers and separator
	X	Deep grove ball bearings cannot sustain radial loads
X		Bearing life is defined as the number of revolutions or hours of operation at constant speed of the inner ring until the first evidence of fatigue occurs.
X		The top bearing speed is limited by the operating temperature of the bearing
	X	A shaft, axle and spindle are all rotating elements that carry power and torque.
X		Bending and torsional deflection and rigidity as well as stress and strength are to be considered in shaft design.
	X	ϕ30 h7 is the dimension of 30 mm dia hole with tolerance grade 7 starting at basic diameter.
	X	Space frames are constructed and supported so as to always allow its motion.
X		Trusses are structures made of simple elements that are always connected and loaded only at their ends and can be only in tension, compression or no load.
X		In the method of joints one does not use moment equilibrium equation for calculation of forces.
X		Gear module is defined as diameter over number of teeth and is measured in [mm]
	X	Coarse gears have lower gear module.

Q2: **10 marks**

Question 2

Calculate rated bearing life L_{10h} in hours of a deep grove ball bearing 6008 (40x68x15) that rotates at constant speed of 5000 rpm while lubricated lubricated by oil. The bearing is loaded with static radial load of F_r=7 kN and axial load of F_a=4.5 kN.

$$L_{10} = \left(\frac{C}{P}\right)^a \qquad [10^6\ rev]$$

$$L_{10h} = \frac{10^6}{60n} L_{10} \qquad [hours]$$

$$L_{10s} = \frac{\pi D}{1000} L_{10} \qquad [10^6\ km]$$

Answer

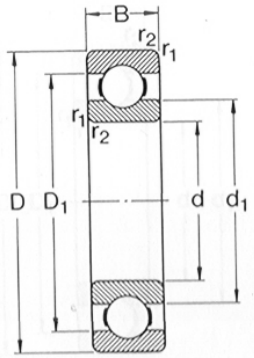
Bearing type	Condition	x	y
Deep groove ball bearing	F_a/F_r<=0.5	1	0
	F_a/F_r>0.5	0.56	1-2
Self aligning ball bearings	F_a/F_r<=e*	1	Y*
	F_a/F_r>e*	0.65	y*
Angular contact ball bearings	F_a/F_r<=1.14	1	0
	F_a/F_r>1.14	0.35	0.57
Double row angular contact ball bearings	F_a/F_r<=0.86	1	0.73
	F_a/F_r>0.86	0.62	1.17
Four-point contact ball bearings	F_a/F_r<=0.95	1	0.66
	F_a/F_r>0.95	0.6	1.07
Cylindrical roller bearing (with flanges)	F_a/F_r<=0.2	1	0
	F_a/F_r>0.2	0.92	0.6
Needle roller bearings	-	1	0
Trust roller bearings	-	0	1
Taper roller bearings	F_a/F_r<=e*	1	0
	F_a/F_r>e*	0.4	Y*
Taper roller bearings	1.00	0.75	0.60

P=0.56*7000+1*4500 =8420

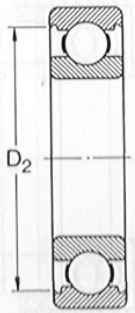
L_{10}=(16800/8420)^3=7.94312 mil rev

L_{10h}=7.94312*1e6/60/5000= 26.5 hours

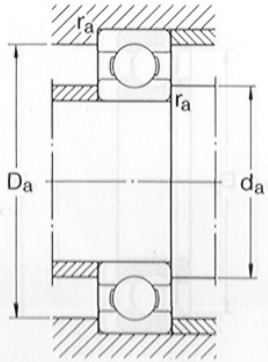
Deep groove ball bearings
single row
d **35–55** mm



With full outer ring shoulders



With recessed outer ring shoulders



Principal dimensions			Basic load ratings dynamic	static	Fatigue load limit	Speed ratings Lubrication grease	oil	Mass	Designation
d	D	B	C	C_0	P_u				
mm			N		N	r/min		kg	–
35	47	7	4 750	3 200	166	13 000	16 000	0,030	**61807**
	55	10	9 560	6 200	290	11 000	14 000	0,080	**61907**
	62	9	12 400	8 150	375	10 000	13 000	0,11	**16007**
	62	14	15 900	10 200	440	10 000	13 000	0,16	**6007**
	72	17	25 500	15 300	655	9 000	11 000	0,29	**6207**
	80	21	33 200	19 000	815	8 500	10 000	0,46	**6307**
	100	25	55 300	31 000	1 290	7 000	8 500	0,95	**6407**
40	52	7	4 940	3 450	186	11 000	14 000	0,034	**61808**
	62	12	13 800	9 300	425	10 000	13 000	0,12	**61908**
	68	9	13 300	9 150	440	9 500	12 000	0,13	**16008**
	68	15	16 800	11 600	490	9 500	12 000	0,19	**6008**
	80	18	30 700	19 000	800	8 500	10 000	0,37	**6208**
	90	23	41 000	24 000	1 020	7 500	9 000	0,63	**6308**
	110	27	63 700	36 500	1 530	6 700	8 000	1,25	**6408**
45	58	7	6 050	4 300	228	9 500	12 000	0,040	**61809**
	68	12	14 000	9 800	465	9 000	11 000	0,14	**61909**
	75	10	15 600	10 800	520	9 000	11 000	0,17	**16009**
	75	16	20 800	14 600	640	9 000	11 000	0,25	**6009**
	85	19	33 200	21 600	915	7 500	9 000	0,41	**6209**
	100	25	52 700	31 500	1 340	6 700	8 000	0,83	**6309**
	120	29	76 100	45 000	1 900	6 000	7 000	1,55	**6409**

Dimensions					Abutment and fillet dimensions		
d	d_1 ≈	D_1 ≈	D_2 ≈	$r_{1,2}$ min	d_a min	D_a max	r_a max
mm					mm		
35	38,7	43,5	–	0,3	37	45	0,3
	41,6	48,6	–	0,6	39	51	0,6
	44	53,3	–	0,3	37	60	0,3
	43,7	53,6	55,7	1	40	57	1
	46,9	60,6	62,7	1,1	41,5	65,5	1
	49,5	66,1	69,2	1,5	43	72	1,5
	57,4	80,6	–	1,5	43	92	1,5
40	43,7	48,5	–	0,3	42	50	0,3
	47	55,2	–	0,6	44	58	0,6
	49,4	57	–	0,3	42	66	0,3
	49,2	59,1	61,1	1	45	63	1
	52,6	67,9	69,8	1,1	46,5	73,5	1
	56,1	74,7	77,7	1,5	48	82	1,5
	62,8	88	–	2	49	101	2
45	48,7	54,5	–	0,3	47	56	0,3
	52,3	60,8	–	0,6	49	64	0,6
	55	65,4	–	0,6	49	71	0,6
	54,7	65,6	67,8	1	50	70	1
	57,6	72,9	75,2	1,1	51,5	78,5	1
	62,1	83,7	86,7	1,5	53	92	1,5
	68,9	96,9	–	2	54	111	2

Q3: **10 mark**s
Each correct answer 1 mark

Question 3

Complete missing lines

Failure modes can be classified in three groups:

1. When capability falls below desired performance due to:
    - Deterioration
    - Lubrication failure
    - Dirt
    - Disassembly
    - 'Capability reducing ' human errors.

2. When desired performance rises above initial capability
    - Sustained, deliberate overloading
    - Sustained, unintentional overloading
    - Sudden, unintentional overloading
    - Incorrect process material.

3.When the asset is not capable of doing what is wanted from the outset.