City University London

Term 2 Assessment, 2006/2007

School of Engineering and Mathematical Sciences

ME1105 Engineering Drawing & Design

SOLUTIONS

Student Name: ..... Group: .....

Max. No of Marks: **30**

Examination duration: 50 min.
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!

Question 1

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

T	F	
	X	Engineering design process is an individual task performed to meet some requirement of humankind.
X		Mechanical design process is the use of scientific principles and technical information to define machine that will optimally perform a required function.
	X	General-purpose elements are components of the same machine which are different in the shape and geometry and carry out different tasks.
	X	The isolated system together with all forces and moments due to any external effects and the reactions with the main system is called equilibrium.
X		Strength is an inherent property of a material built into the part because of the use of a particular material and process.
	X	Stress is a state property of a body which is not a function of load, geometry, temperature and manufacturing processing.
	X	A static load is a force or moment with frequent change in magnitude, point of application and direction that acts on a member of a machine or mechanism
X		A static load can be axial tension, compression, a shear load, a bending load, a torsional load or any combination of these.
	X	If the time of application of load is shorter than three times its natural period, dynamic effects are neglected and the load can be considered static.
X		Factor of safety is ratio between loss of a function load and allowable load.
X		Factor of safety is ratio between strength and stress of a material.
X		Thread pitch is a distance between adjacent thread forms measured parallel to the thread axis.
	X	Metric threads are usually pipe threads.
X		Both metric and unified threads can have coarse and fine pitch.
	X	A component that prevents relative motion between two bodies is called bearing.
	X	Ball bearings take more load then cylindrical bearings.
X		Rating life of a bearing, L_{10} is number of revolution or hours of operation that 90% of a group of identical bearings will achieve or exceed before the failure.
	X	An axle is a rotating element that carries torque and is supported by rotating bearings.
	X	The reason to use gears in speed reducers is because torque is easy to generate, while speed is not.
X		The fundamental premise of gearing is to maintain a constant relative rotation rate of gears.
X		Trusses are structures composed entirely of members that are loaded with forces in two points
X		The method of joints employs the summation of forces at a joint to calculate forces in members.
	X	A failure mode is any event that prevents a functional failure of a machine or a system.
X		Failure effects describe what happens when a failure mode occurs.

Question 2

Calculate a rated bearing life L_{10} in numbers of revolutions and L_{10s} in kilometers of a four point contact angular ball bearing QJ206MA (30x62x16) that rotates at maximum constant speed of 2000 rpm while lubricated by grease. The wheel diameter is 500 mm. The bearing is loaded with static radial load of F_r=15 kN and axial load of F_a=10 kN. How fast is car moving in this case (in km/hour)?

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

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

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

Answer

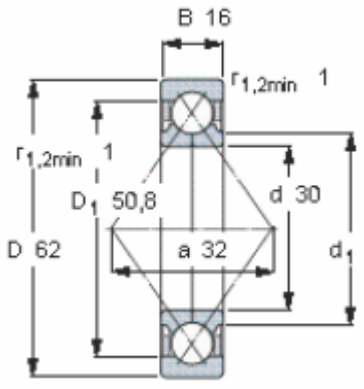
Bearing type	Condition	x	y
Deep groove ball bearing	F_a/F_r<=0.5	1	0
	F_a/F_r>0.5	0.56	1-2
Self aligning ball bearings	F_a/F_r<=e*	1	Y*
	F_a/F_r>e*	0.65	y*
Angular contact ball bearings	F_a/F_r<=1.14	1	0
	F_a/F_r>1.14	0.35	0.57
Double row angular contact ball bearings	F_a/F_r<=0.86	1	0.73
	F_a/F_r>0.86	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

$\underline{P=1.0*15+0.66*10 =21.6kN}$

$\underline{L_{10}=(37.5/21.6)^3=5,230,000\ rev}$

$\underline{L_{10s}=3.14*0.5*5,230,000/1,000= 8211\ km}$

$\underline{Speed=0.5*3.14*2000*60/1000=188.4\ km/h}$



Angular contact ball bearings, four-point contact ball bearings

Principal dimensions			Basic load ratings		Fatigue load limit	Speed ratings		Mass	Designation
			dynamic	static		Reference speed	Limiting speed		
d	D	B	C	C0	Pu				* - SKF Explorer bearing
mm			kN		kN	r/min		kg	-
15	35	11	12,7	8,3	0,355	22000	36000	0,062	QJ 202 N2MA
17	40	12	17	11,4	0,45	22000	30000	0,082	QJ 203 N2MA *
17	47	14	23,4	15	0,64	17000	28000	0,14	QJ 303 N2MA
20	52	15	32	21,6	0,85	18000	24000	0,18	QJ 304 MA *
20	52	15	32	21,6	0,85	18000	24000	0,18	QJ 304 N2MA *
20	52	15	32	21,6	0,85	20000	24000	0,16	QJ 304 N2PHAS *
25	52	15	27	21,2	0,83	16000	22000	0,16	QJ 205 MA *
25	52	15	27	21,2	0,83	16000	22000	0,16	QJ 205 N2MA *
25	62	17	42,5	30	1,18	15000	20000	0,29	QJ 305 MA *
25	62	17	42,5	30	1,18	15000	20000	0,29	QJ 305 N2MA *
30	62	16	37,5	30,5	1,2	14000	19000	0,24	QJ 206 MA *
30	62	16	37,5	30,5	1,2	14000	19000	0,24	QJ 206 N2MA *
30	72	19	53	41,5	1,63	12000	17000	0,42	QJ 306 MA *
30	72	19	53	41,5	1,63	12000	17000	0,42	QJ 306 N2MA *
30	72	19	53	41,5	1,63	14000	17000	0,37	QJ 306 N2PHAS *
35	72	17	49	41,5	1,63	12000	17000	0,36	QJ 207 N2MA *
35	80	21	64	51	1,96	11000	15000	0,57	QJ 307 MA *
35	80	21	64	51	1,96	11000	15000	0,57	QJ 307 N2MA *
35	80	21	64	51	1,96	13000	15000	0,48	QJ 307 N2PHAS *
40	80	18	56	49	1,9	11000	15000	0,45	QJ 208 MA *
40	80	18	56	49	1,9	11000	15000	0,45	QJ 208 N2MA *
40	90	23	78	64	2,45	10000	14000	0,78	QJ 308 MA *
40	90	23	78	64	2,45	10000	14000	0,78	QJ 308 N2MA *
45	85	19	63	56	2,16	10000	14000	0,52	QJ 209 MA *
45	100	25	100	83	3,25	9000	12000	1,05	QJ 309 MA *

Question 3

a) List and very briefly explain 10 stages of the design process and comment on the importance of a structured design process.

b) Explain the term "Criteria" and state how the criteria is set and used in later stages of the design process.

c) Explain the term "Decision" and state how the decision is obtained and how the criteria are used during the decision making phase. Explain the decision matrix.

a)
- **Identify a need** - must be done before the design process starts
- **Define the problem** - to focus the design to the solution of required problem
- **Search** -obtain relevant information, overlaps with other phases
- **Constraints** - to bound problem with physical and practical limitations
- **Criteria** - specify criteria which will be later used in decision making
- **Alternative solutions** - Brainstorming to define as many solutions as possible
- **Analysis** - Mathematical model to analyze alternative solutions against laws of physics, economy and common sense
- **Decision** - Selection by use of design matrix based on specified criteria
- **Specification** - Detailed design: detailed and assembly drawings, bill of material, and other specifications
- **Communication** - Communication with technical and other people through written reports and oral presentations.
- **Structured engineering design** is essential in the world with lively market and huge competition. Only structured design process gives concurrent product.

b) **Criteria** are desirable characteristics of the solution which are established from experience, research, market studies and customer preference. Decision making is later based on the criteria being set.

c) **Decision** is the part of the design process in which one of the alternative solutions have to be selected and later designed in detail. Decision if always 'trade-off' between different criteria. In order to mathematically evaluate solutions, criteria are weighted. Decision matrix helps in organizing the data and easier calculation of scores for all alternative solutions