UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *MECHANICAL ENGINEERING*
SUBJECT	:	**Design 2 (Mechanical)**
CODE	:	**OWM2B**
DATE	:	SUMMER EXAMINATION NOVEMBER 2016
DURATION	:	3 hrs
WEIGHT	:	50 : 50
TOTAL MARKS	:	100

EXAMINER	:	Dr BW Botha
MODERATOR	:	Dr A Maneschijn
NUMBER OF PAGES	:	3 PAGES

INSTRUCTIONS	:	OPEN BOOK – ONLY SHIGLEY.
REQUIREMENTS	:	ANSWER BOOKLET.

INSTRUCTIONS TO CANDIDATES:

- THE EXAMINATION IS AN OPEN BOOK WITH RESPECT TO THE PROBLEMS IN SHIGLEY. ONLY SHIGLEY IS ALLOWED, NO OTHER NOTES.
- PLEASE ANSWER ALL THE QUESTIONS.
- ***IF YOU WOULD CHANGE YOUR MIND AS TO YOUR PREFERRED ANSWER THE INCORRECT ANSWER IS TO BE CLEARLY CANCELLED. IF MULTIPLE ANSWERS ARE SUPPLIED FOR ANY PROBLEM WITHOUT CANCELLATION OF THE INCORRECT ANSWER THE FIRST ANSWER WILL BE MARKED AND ANY FOLLOWING ANSWERS WILL BE DISCARDED.***
- SHOW CALCULATIONS CLEARLY AND MOTIVATE ALL ASSUMPTIONS.

QUESTION 1

30 Marks

As resident engineer you are asked to design a belt drive for a petrol motor with a maximum power rating of 2.75 kW at 2750 rpm. The motor is to be fitted with a V-belt configuration to drive a load as close to 950 rpm as possible at full power under light shock conditions. The belt speed is to be limited to approximately 15 m/s with a minimum service factor of 1.25 and design factor of 1.2. In order to limit spares, you are informed to standardize components as per the spares stock. This includes using an A2125 V-belt and standard pulley diameters listed in the relevant table as commercially available pulleys, increasing in steps of 30mm in diameter above the maximum listed. Calculate the:

a. Centre distance,
b. Required pulley configuration,
c. Pre-tension required and
d. Factor of safety

QUESTION 2

30 Marks

Use the Ohio State University Reverse Engineering Methodology to do a brief reverse engineering exercise on the spirit level shown in the figure below.

Include

(a) At least four user requirements for the spirit level.
(b) Design specifications to be included in the PDS ensuring that the requirements in (a) will be satisfied.

(c) Use the functions and requirements above to propose two concepts for a **simplified** spirit to reduce the **manufacturing** costs. Support your discussions with simple, freehand sketches as relevant.
(d) Evaluate the concepts using a scientific selection method.
(e) Propose material for the main components of the chosen concept

QUESTION 3

20 Marks

3.1 A certain application requires a ball bearing with the inner ring rotating, with a design life of 35 000 hours at a speed of 350 rpm. The radial load is 2.2 kN and an application factor of 1.2 is appropriate. The reliability goal is 0.90. Determine the following:
a. Multiple of rating life required (x_D)
b. Catalogue rating (C_{10})
c. Specify a 02-series deep groove ball bearing.

[10]

3.2 Give two possible applications for each of the following: [6]
a. Linear bearing
b. Thrust bearing
c. Tapered roller bearing

3.3 Explain the purpose of a sprag or trapped roller bearing. [1]

3.4 Explain the principle that a magnetic bearing works on and what are the main benefits. [3]

QUESTION 4

20 Marks

4.1 A single square-thread power screw has an input power of 3 kW at a speed of 1 rev/s. The screw has a major diameter of 36 mm and a pitch of 6 mm. The frictional coefficients are 0.14 for the threads and 0.09 for the collar, with a collar friction radius of 45 mm. Calculate the:
(a) axial force F that can be raised,
(b) combined efficiency of the screw and collar,
(c) bearing stress for the maximum loaded thread
(d) thread-root bending stress.

[14]

4.2 Indicate the components of a joint analysis assuming that all bolts in a bolted joint carry equal load. [6]

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QUESTION 1

30 Marks

Two shafts, 4.5 m apart, are to be connected with a polyamide F-2 flat belt in which the 125 mm diameter driving pulley drives the second shaft though a 350 mm pulley. The driving pulley is driven by a 45 kW electric motor running at 1140 rpm driving light shock machinery loads with a minimum service factor of 1.2 and an initial design factor of 1.1. You are tasked to determine the required belt width to ensure that the power is transferred without slippage. For safety purposes it is required to box the belt. For this it is important to know how much the belt will dip. Standard belt widths increase in steps of 25 mm between 100 and 300 mm wide belts, 50 mm between 300 and 600 mm and 75 mm above 600mm.

QUESTION 2

30 Marks

Use the Ohio State University Reverse Engineering Methodology to do a brief reverse engineering exercise on the tool box (excluding the tools) shown in Figure Q2.

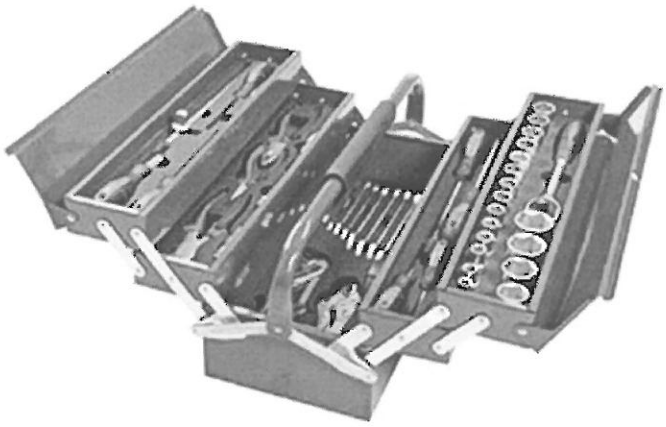


Figure Q2 : *Toolbox*

Include

(a) At least five user requirements for the toolbox.

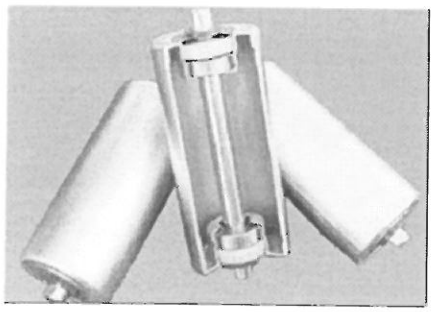
(b) Design specifications to be included in the PDS ensuring that the requirements in (a) will be satisfied.

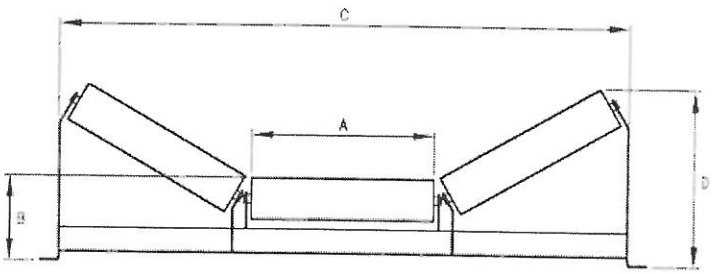
(c) Use the functions and requirements above to propose two concepts for a **simplified** toolbox to reduce the **manufacturing** costs. Support your discussions with simple, freehand sketches as relevant.
(d) Evaluate the concepts using a scientific selection method.
(e) Propose material for the main components of the chosen concept

QUESTION 3

20 Marks

As maintenance engineer you need to specify an appropriate roller bearing for a conveyor idler similar to that shown in the figure. To satisfy the belt requirement the idler has to have a minimum distance between bearing centres of A=500 mm. The idler is to be rated for a maximum distributed load of 4500 N/m and a minimum application factor of 1.2. The application is to have a minimum required service interval for bearing replacement of 45 000 h at a speed of 300 rpm and a reliability goal of 0.97.





Determine the following:

a. The required bearing load for the horizontal
b. Multiple of rating life required (x_D)
c. Catalogue rating (C_{10})
d. Specify a 02-series deep groove ball bearing

QUESTION 4

20 Marks

The cantilever bracket in the figure is bolted to a column with three M12 x 1.75 ISO 5.8 bolts. The bracket is made from AISI 1020 hot rolled steel. Assume the bolt threads do not extend into the joint. Find the factors of safety for the following failure modes:

a. Shear of bolts
b. Bearing of bolts
c. Bearing of bracket
d. Bending of bracket