UNIVERSITY OF JOHANNESBURG

PROGRAM	:	BACCALAUREUS INGENERIAE *MECHANICAL ENGINEERING SCIENCE*
SUBJECT	:	**DESIGN (MECHANICAL) 3B**
CODE	:	**OWMMCB3/OWM3B21**
DATE	:	SUMMER EXAMINATION (SUPPLEMENTARY) JANUARY 2020
DURATION	:	3 hours
WEIGHT	:	50:50
TOTAL MARKS	:	100

EXAMINER	:	DR. A. MANESCHIJN
MODERATOR	:	DR D.M. MADYIRA
NUMBER OF PAGES	:	5 PAGES

REQUIREMENTS	:	ANSWER BOOKLETS NOTES - OPEN BOOK CALCULATOR

INSTRUCTIONS TO CANDIDATES:

- ANSWER ALL THE QUESTIONS
- NO WRITTEN ANSWERS IN PENCIL WILL BE MARKED
- ONE (1) MARK PER FACT

QUESTION 1 (Mechatronics): **[20]**

Consider the modern washing machine shown in Fig. 1.

Fig. 1: Modern washing machine

a) Define what makes a system a mechatronics system. Then describe why the washing machine shown in Fig. 1 is an example of a mechatronics system, while older washing machines (30 years old and older) are not.

(5)

b) List the main elements of the washing machine in Fig. 1 and then use these elements as a basis to draw a flow chart of the operation of the washing machine during a normal cycle of washing, rinsing and spinning. Focus on the primary functions such as weighing the washing, selecting the cycle times, etc.

(15)

QUESTION 2 (Design for Manufacturing): **[20]**

a) How does a design engineer design for manufacturing, and why is it important?

(4)

b) Fig. 2 shows the initial design and a re-designed mechanical clamp (made from metal parts) for the same purpose. In a table, list **five (5)** primary **design** differences between the initial design and the re-design of the mechanical clamp and describe how those differences have improved the manufacturing of the clamp. Give specific examples of what was improved (e.g. cost) and say why there was an improvement. Give **1 (one)** example of a further design improvement that you would incorporate to further optimise the manufacturing of the clamp. (Note: "cost" was given as an example – do not use cost in your answer!)

(16)

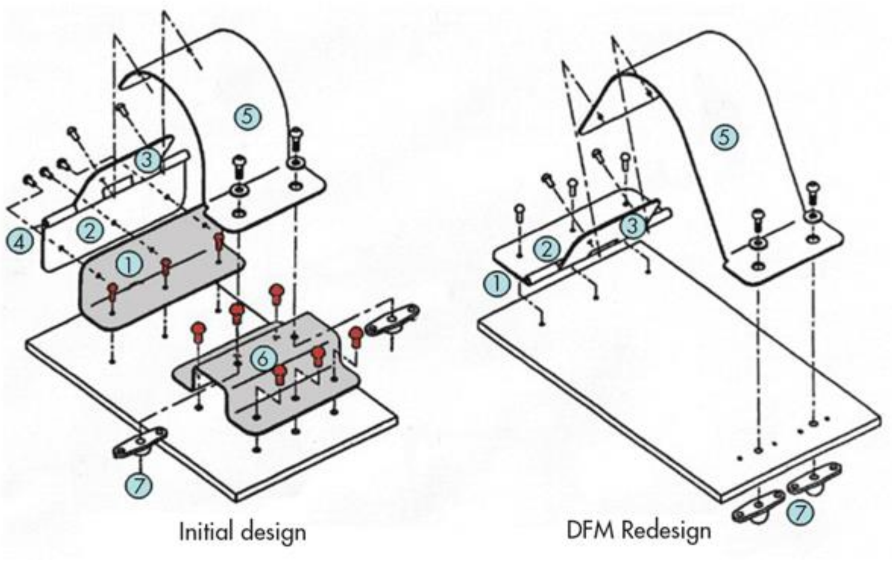

Fig. 2: Metal mechanical clamp

QUESTION 3 (Design for maintenance): **[20]**

a) The vehicle maintenance facility shown in Fig. 3 (see page 4) is used for doing maintenance on high-end luxury and sports vehicles. Using a bulleted list, define **10 (ten)** elements of the maintenance facility that must be designed specifically for this type of maintenance work and describe briefly for each of the elements why it is important to design the elements for this facility. (Note: The focus is on the machinery and equipment of the maintenance facility, **not** the maintenance of the vehicles!)

(20)

Fig. 3: High-end vehicle maintenance facility

QUESTION 4 (3D printing): **[20]**

A CNC-machined **aluminium** part and an identical **plastic** 3D printed part are shown in Fig. 4.

a) If the 3D printed part must be printed in **aluminium**, define the most appropriate 3D printing process that you would use and describe how the process constructs the 3D printed part.

(10)

b) Briefly describe **5 (five)** main differences (in a table) between CNC-machining the part and 3D printing the part with the process you selected in question (a). Also indicate what effects the differences have on the final product in terms of quality, strength, price and other relevant end-product features.

(10)

Fig. 4: CNC-machined aluminium part and its plastic 3D printed equivalent

QUESTION 5 (Rivets): **[20]**

A force P of 1200 N is applied to the multi-riveted joint shown in Fig. 5. Determine the **minimum** rivet diameter in millimeter that would be required to prevent failure of the joint. The design stresses are
$(\sigma_{all})_{tension}$ = 240 MPa, $(\tau_{all})_{shear}$ = 110 MPa, $(\sigma_{all})_{bearing}$ = 300 MPa.

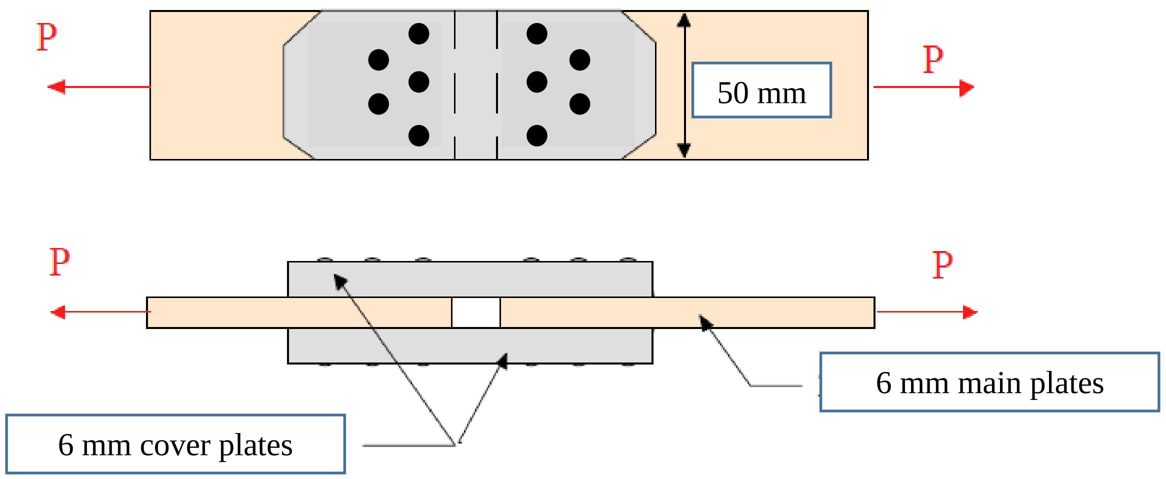

Fig. 5: Multi-riveted joint