

**FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA**  
**DEPARTMENT OF MECHTRONICS ENGINEERING**  
**SECOND SEMESTER EXAMINATION 2018/2019 SESSION**

**Course Code: MCE 321**

**Time: 2hr 30Min.**

**Instructions: Attempt four questions in all, and atleast question 5 or 6 is compulsory. All questions carry equal mark.**

- Q1. An elemental part shaft of a flying robot subjected to combined stresses is expanded as shown in figure 1. Determine using Morh's circle method:
- a) The principal planes. 5 marks
  - b) The principal stresses. 5 marks
  - c) The maximum shear stress and the corresponding normal stress. 5 marks

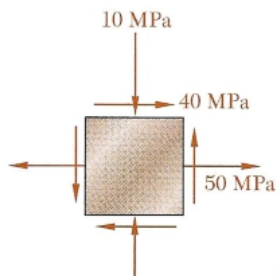


Figure 1:

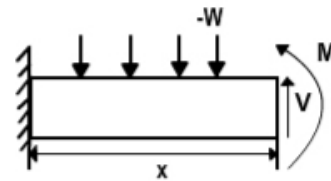
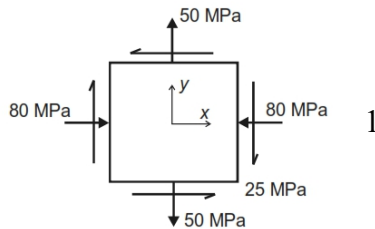


figure 2:

- Q2. Part of the supporting structure of a robotic arm is shown in figure 2.  $W = 0.5 \text{ N/m}$  and  $x = 200\text{cm}$ . Determine the maximum shear force and bending moment. And plot them. 15marks

- Q3a) From first principle derive the principal stress equations 1 and 2 for a stress at a point in body. 8 Marks
- b). The state of plane stress at a point extracted from a component in a moving mobile robot is represented by the stress element below. Determine the principal stresses and their angles. 7 Marks



2

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}$$

$$\tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

- Q4a). An engineer design a conveyor system for transporting fruits can in a production line. What are the factors he/she need to consider in selecting a belt drive. 4 marks
- b). State the possible belt type he/she can used in the design. 3 marks

- c) The pulley of a lathe machine is driven by a flat belt running at a speed of 600 m/min. the coefficient of friction between the pulley and the belt is 0.3 and the angle of lap is  $160^\circ$ . if the maximum tension in the belt is 700 N. Find the power transmitted by a belt.  
8 marks.
- Q5a) What constitute gear train? Hence using diagrams only, show the following gear trains; simple, compound, reverted and planetary types respectively  
[ 7 Marks]
- b) In a planetary gear train, gear1 was fixed: Calculate for number of teeth in gear2, given that gear1 had 40 teeth. The ratio of speed of gear2 to arm was 3:2  
[3 Marks]
- c) What is brake? List three main types of brakes [5 Marks]
- Q6a) With supporting diagram, show what cam and follower type is used in a sewing machine's needle mechanism [2 Marks]
- b) Show the follower displacement diagram for a  $1440^\circ$  cycles of operation  
[8 Marks]
- c) List five factors you would need to consider as an engineer in charge of brake selection for a company you work for when you graduate from F.U.T. Minna  
[5 marks]