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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017**

COURSE NAME : ROBOTICS & AUTOMATION
SYSTEM
COURSE CODE : DAE 32503
PROGRAMME : 3 DAE
EXAMINATION DATE : DECEMBER 2016/JANUARY 2017
DURATION : 2 HOURS 30 MINUTES
INSTRUCTION : **PART A: ANSWER ALL
QUESTIONS.
PART B: ANSWER ALL
QUESTIONS.
PART C: ANSWER TWO (2)
QUESTION ONLY.**

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THIS QUESTION PAPER CONSISTS OF ELEVEN (11) PAGES

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**PART A: Objectives
(40 marks)**

- Q1** From the following, which is not composed of an automated machine?
- (a) Electronic circuit.
 - (b) Mechanical part including the actuators/drives.
 - (c) Operator who control the machine.
 - (d) Control system that represents the intelligence of the system.
- Q2** The causes of worker injury in a robotic environment vary and include the following; **EXCEPT**
- (a) Excessive physical strain
 - (b) Being struck by a part or robot gripper
 - (c) Obeying safety rules and regulation of authoritative organization
 - (d) Falling from equipment or structure
- Q3** For eliminating hazards in workplace, professional organizations have define the following guide. Rearrange them by priorities;
- (i) Apply safeguarding technology
 - (ii) Train and instruct the worker, programmer and maintenance personnel
 - (iii) Prescribe personal protective equipment and devices
 - (iv) Use warning sign and labels.
- (a) (i), (ii), (iii), (iv) (c) (i), (iv), (ii), (iii)
(b) (iii), (iv), (ii), (i) (d) (iv), (iii), (ii), (i)
- Q4** Which is not **TRUE** about autonomous system:
- (a) Bread is put in the toaster, a lever is pushed down, and when the toast is done, it shuts off and pops up.
 - (b) The traffic light uses a camera and moves its camera to detect people who want to cross the street and change its light accordingly.
 - (c) Vacuum cleaner that deliver excellent cleaning floor, avoid obstacles, self-battery charging and self-empty dustbin.
 - (d) Home gate uses camera to recognize owner and open the gate and close after the car safely park.
- Q5** Choose **ONE** advantage of robot;
- (a) Robot have limited capabilities in real-time response
 - (b) Robot are cheaply-cost due to need for training
 - (c) Robot can be much more accurate than humans
 - (d) Sensor and vision system is robots superior capabilities

Q6 Listed below are **NOT** examples of automated manufacturing system:

- i. Automatic inspection system for quality control.
 - ii. Automatic material handling and storage systems to integrate manufacturing operations.
 - iii. Manufacturing systems that use industrial robots to perform processing or assembly operations.
 - iv. Automated machine tools that process machine parts.
 - v. Transfer lines that perform a series of machining operations.
- (a) (iii), (iv) & (v) (c) (i), (iii) & (v)
(b) (ii), (iii) & (iv) (d) none of above

Q7 Identify typical features of fixed automation

- (a) Low number of different parts in product variety relative to high production volume.
- (b) High production volume relative with low product variety.
- (c) Low investment for custom-engineered equipment.
- (d) Relatively flexible in accommodating product changes.

Q8 Which is **NOT TRUE** about programmable automation;

- (a) Most suitable for batch production.
- (b) Low production rates relative to fixed automation.
- (c) Low investment in general-purpose equipment.
- (d) Flexibility to deal with changes in product configuration.

Q9 The essential features that distinguish flexible automation from programmable automation are:

- i. the capacity to change part programs with no lost production time.
 - ii. the capability to change over the physical setup with no lost production time.
 - iii. the system can produce various combinations product by requiring they be made in separate batches.
- (a) All of above (c) (i) & (iii)
(b) (i) & (ii) (d) (ii) & (ii)



Q10 The PLC is a computer designed for control of manufacturing process, assembly systems and general automation. Which is **NOT** true about PLC from the following statements?

- (a) The PLC components are power supply, input and output modules, processor and communication modules.
- (b) Input modules receives electrical signal from PLC processor.
- (c) The PLC communication modules are not used as frequently as input and output modules.
- (d) The output modules are wired to system components that control the process.

Please refer **Figure 1** for Question 19 and 20.

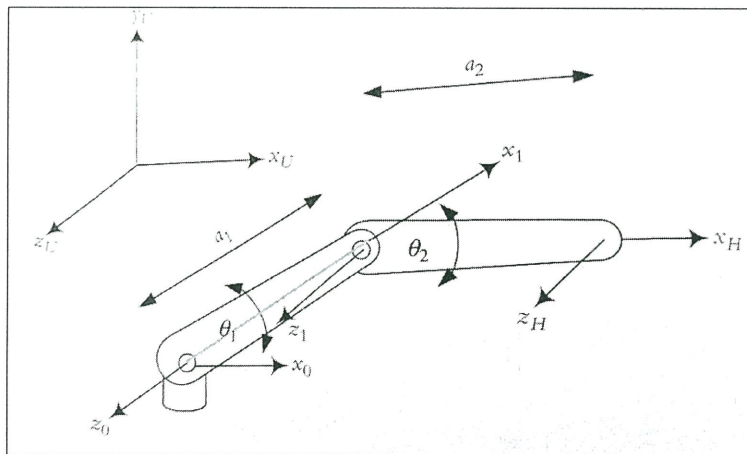


Figure 1: Articulated 2-axis robot arm.

Q11 Identify D-H parameter of Link 0-1, for the robot arm as in **Figure 1**. Use θ , d , a and α priority.

- (a) $0, 0, z_1, 0$
- (b) $\theta, 0, a_1, 0$
- (c) $a_1, z_1, 0, 0$
- (d) $z_0, \theta, a_1, 0$

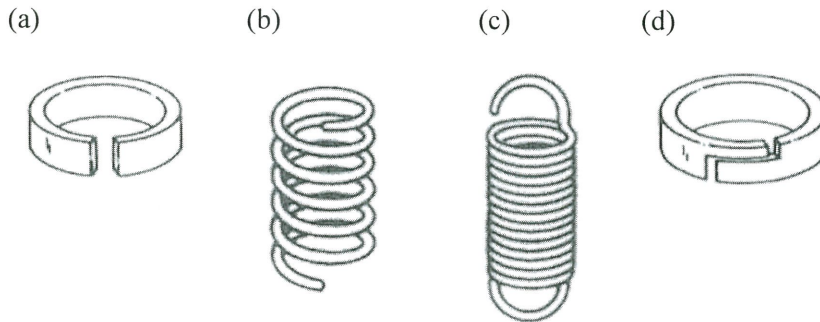
Q12 According D-H convention, the following are transformation required **EXCEPT**

- (a) Translate about the z_0 -axis an angle of θ , to make x_0 parallel to x_1 .
- (b) Since x_0 and x_1 are in the same plane, translation d along the z_0 -axis is zero.
- (c) Translate along the (already rotated) x_0 -axis a distance of a_1 .
- (d) Since z_0 and z_1 - axis are parallel, the necessary rotation α about the x_1 -axis is zero.

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Q13 Device developers put a lot of time and energy into the design of a new product. However, they may forget that all design needs to consider the next stages of manufacture, including automation for assembly. Choose the most preferred design for feeding part;



Q14 Why designer for automation should consider of shapes for feeding parts?

- (a) To make components stuck together.
- (b) To prevent parts from wedging together.
- (c) To stick part easily together.
- (d) Parts will jam in feeding line.

Q15 The following characteristic of industrial environment were promoted the used of robot in replacing human labour **EXCEPT**;

- (a) Repetitive tasks.
- (b) Multi-shift operations
- (c) Maximizing variations.
- (d) Performing at a steady pace.

Q16 The following are basic categories of industrial robot applications **EXCEPT**;

- (a) Processing operations.
- (b) Assembly operations.
- (c) Freight operations.
- (d) Inspection operations.

Q17 Die casting is an application of industrial robot for loading and unloading process. State a problem encountered during this process.

- (a) The cycle time of the machine may be relatively always synchronous compared to the robot's cycle time.
- (b) The difference in cycle time between the robot and the production machine.
- (c) Robot too heavy to handle the process.
- (d) Tedious job that makes robot can't complete the task.

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- Q18** Spot welding, spray painting and deburring are examples of industrial robot applications in;
- (a) material handling.
 - (b) inspection operation.
 - (c) assembly operation.
 - (d) processing operations.
- Q19** What is the best suit characteristic of robots to perform arc welding jobs?
- (a) Programming is typically done by walk-thru method.
 - (b) SCARA coordinate robots are frequently used.
 - (c) The robot must be capable of continuous path control.
 - (d) The robot should have only 3 to 4 axes.
- Q20** In modern robot installations, appropriate sensors orientate the gripper of the end effector to deal with random entry of parts into the cell. For material handling operations, the robot must have the following features, **EXCEPT**:
- (a) The manipulator must be able to lift the part safely.
 - (b) The robot must have the reach needed.
 - (c) The robot must be a SCARA coordinate type.
 - (d) The robot must have the speed necessary for meeting the transfer cycle of the operation.

PART B

A company called Chokelat decide to set-up a **flexible manufacturing system (FMS)** in their new plant. This company produces a variety of chocolate based products. Explain all flexibility tests they should go through to qualify to be FMS.

(10 marks)

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PART C

- Q1** (a) Robot originated from the Czech word “ROBOTA” meaning literally work/labour/slave labourer.
- (i) Who introduce the term robotics? (1 marks)
 - (ii) State **two (2)** key features of a robot. (2 marks)
 - (iii) Discuss **three (3)** reasons for using robots instead of humans to perform a task. (6 marks)
- (b) Great care must be taken in workcell design to anticipate all possible mishaps that might occur during the operation of the cell and to design safeguards to prevent or limit the damage resulting from these mishaps.
- (i) Illustrate and label the **three (3)** level of safety sensor system in robots workcell as defined by the National Bureau of Standard. (5 marks)
 - (ii) Propose the most suitable sensor for each level illustrated in Q1(b)(i). (3 marks)
- (c) The Yamaha YK-350X robot can be programmed using a teach pendant to perform pick and place operation as shown by **Figure Q1(c)**.
- (i) Prepare a simple program to pick and place a pallet from workstation A to workstation B. (5 marks)
 - (ii) Which path control is more suitable for the operation, linear or point to point? Justify your answer. (3 marks)
- Q2** (a) An industrial robot consists of a number of components as shown by **Figure Q2(a)**.
- (i) Describe the primary function of manipulator, controller and end effector. (5 marks)
 - (ii) Sketch the general block diagram of a robot’s controller. (4 marks)
 - (iii) State the other **two (2)** methods to program a robot apart from using a teach pendant. (2 marks)



- (iv) Actuators are used to move the manipulator. State the types of actuators commonly used in the industry. (3 marks)
 - (b) Richard wants to build a simple robot that can perform a pick and place operation. The robot is required to transfer boxes filled with soft drinks as shown in **Figure Q2(b)** from station A to station B. The robot will be installed in between the two stations.
 - (i) Suggest how many degrees of freedom (d.o.f) the robot should have. Explain your answer. (3 marks)
 - (ii) Choose suitable type of Actuator(s), Sensor(s) and End effector that Richard should use to build the robot. Explain your choices. (8 marks)
- Q3**
 - (a) Industrial robots can be classified into five (5) configurations. Referring to **Figure Q3(a)**,
 - (i) Identify the robot's configuration. (1 marks)
 - (ii) Sketch the robot's work envelope. (3 marks)
 - (iii) Describe a specific application of the robot in the industry. (2 marks)
 - (b) Describe the criterias/specifications for robot selection? (4 marks)
 - (c) Apart from industrial robots, there are also different types of non-industrial robot such as the domestic or personal robot.
 - (i) Give examples of domestic or personal robot available in the market. (3 marks)
 - (ii) Looking at the current advancement of robotics technology, how do you think the domestic or personal robot will affect human's life in the future? (2 marks)

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- (d) **Figure Q3(d)** shows frame {B} rotated by Θ degrees with respect to reference frame {A} about x -axis, y -axis and z -axis.
- (i) Derive the matrix that represents a pure rotation about the z -axis of the reference frame. (5 marks)
- (ii) Determine the coordinates of point $P = [3, 5, 7]^T$ relative to the reference frame {A} after a rotation of 90 degrees about the z -axis. (3 marks)
- (iii) After the rotation in Q3(c)(ii), frame {B} is then translated by 3 units along the x -axis, 6 units along the y -axis and 2 units along the z -axis. Determine the final coordinates of point P. (2 marks)

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- END OF QUESTION -

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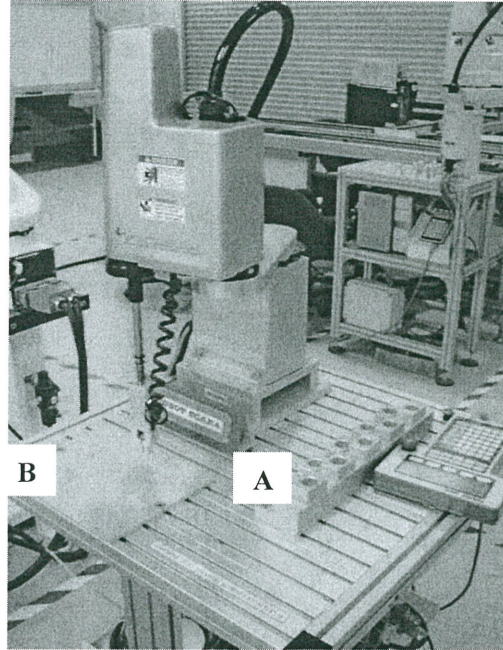


FIGURE Q1(c)

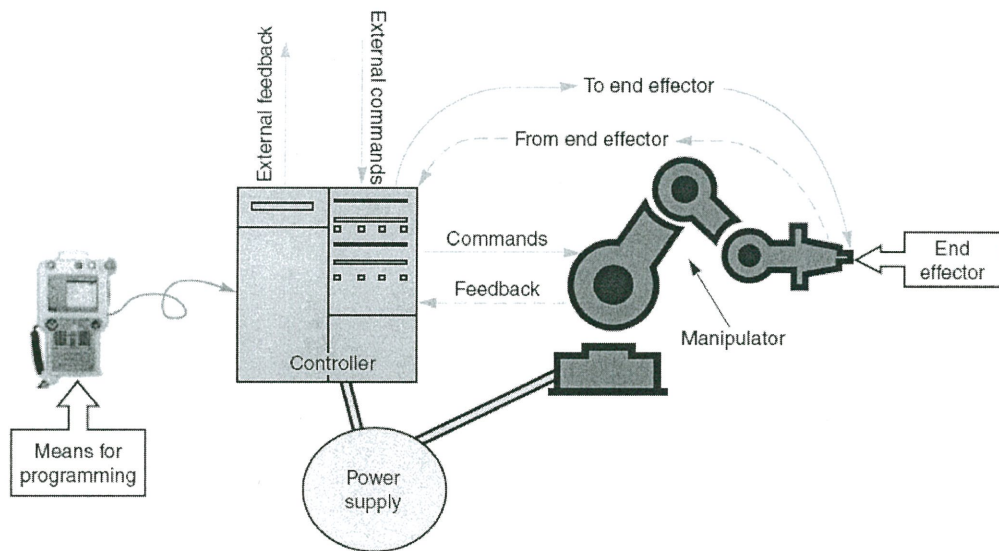


FIGURE Q2(a)

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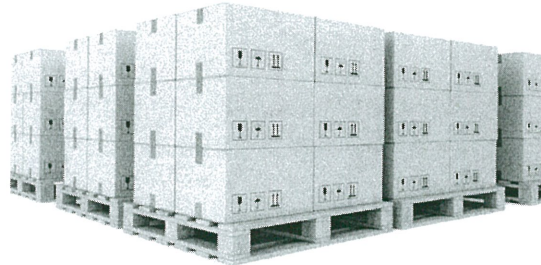


FIGURE Q2(b)

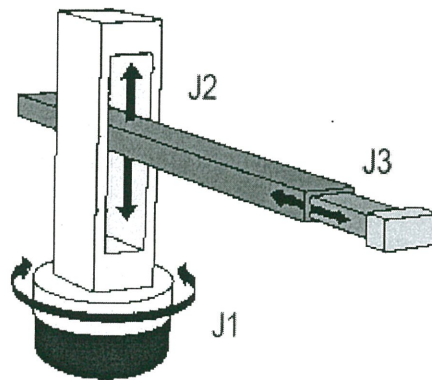


FIGURE Q3(a)

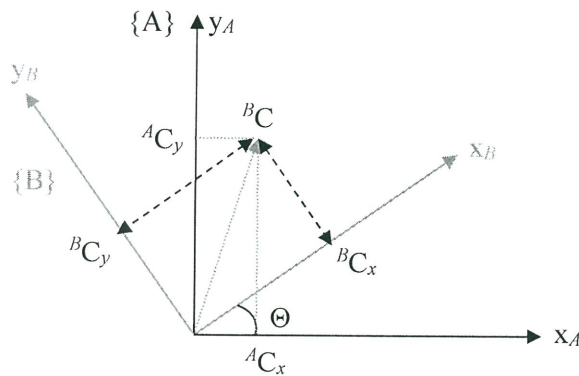


FIGURE Q3(d)

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