



**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2015/2016**

**COURSE NAME : ROBOTICS & AUTOMATION  
SYSTEMS**  
**COURSE CODE : DAE 32503**  
**PROGRAMME : 3 DAE**  
**EXAMINATION DATE : DECEMBER 2015/ JANUARY 2016**  
**DURATION : 2 HOURS**  
**INSTRUCTION : ANSWER ALL QUESTIONS**

**THIS QUESTION PAPER CONSISTS OF NINE (9) PAGES**

**SECTION A**

**CONTAINS: 20 Question (40 marks)**

**Q1** 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

**Q2** 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
- (b) iii, iv, ii, i
- (c) i, iv, ii, iii
- (d) iv, iii, ii, i

**Q3** The National Bureau of Standards defines **three (3)** levels of safety sensor system in robots. Which of the following is not include the levels?;

- (a) Intruder detection inside the work cell level.
- (b) Perimeter of fail-safe hazard detector level.
- (c) Perimeter penetration detection.
- (d) Intruder detection in the immediate vicinity of the robot.

**Q4** Which following statement is **TRUE**?

- (a) HONDA introduced its first humanoid robot in 2000
- (b) GM installed its first robot from Unimation in 1962
- (c) Denavit and Hartenberg developed homogeneous transformation matrices in 1944
- (d) The first PUMA robot was shipped to GM by Unimation in 1980

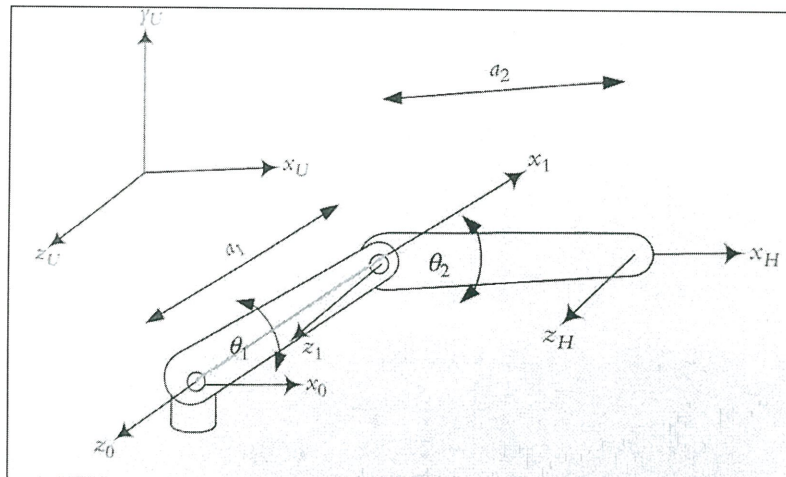
- Q5** Choose **ONE** advantage of robot;
- (a) Robot have limited capabilities in real-time response
  - (b) Robot are cheaply-cost due to need for training
  - (c) Robot can be much more accurate than humans
  - (d) Sensor and vision system is robots superior capabilities
- Q6** The primary reason for selecting a robot is to reduce labour costs. Other reasons for using robots are as follow **EXCEPT**;
- (a) Increase output rate
  - (b) Eliminate dangerous job
  - (c) Reduce product flexibility
  - (d) Improve product quality
- Q7** Basic component of an industrial robot are;
- (a) Controller, manipulator, end-effector and power supply
  - (b) Joint, computer, manipulator and conveyor
  - (c) Teach pendant, power-supply, link and chain
  - (d) Controller, joint, conveyor and gripper.
- Q8** The following are industrial robots configuration categorized by arm geometry **EXCEPT**;
- (a) Cartesian
  - (b) Polar
  - (c) Oblong
  - (d) Selective Compliance Assembly Robot Arm
- Q9** Choose the correct motion for arm geometry robot;
- (a) Cartesian : 2 Rotary, 1 Linear
  - (b) Spherical : 3 Rotary
  - (c) Articulated (vertical) : 3 Linear
  - (d) Cylindrical : 2 Linear, 1 Rotary

- Q10** The advantage of rectangular coordinated robots is
- (a) They makes maintenance easy for some models with overhead drive mechanisms and control equipment.
  - (b) They can carry heavy loads because the weight-lifting capacity does not vary at different locations within the work envelope
  - (c) Their movement is not limited to one direction at a time
  - (d) Their linear movement allow for complex controls
- Q11** Which geometry coordinated robot arm not suitable for assembly application
- (a) Cylindrical
  - (b) Rectangular
  - (c) Spherical
  - (d) SCARA
- Q12** Level of robot programming from Level 1 to Level 4 are;
- (a) Primitive Motion Function → Task-oriented Function → Structured Programming Function → Joint Control Function
  - (b) Joint Control Function → Primitive Motion Function → Structured Programming Function → Task-oriented Function
  - (c) Structured Programming Function → Task-oriented Function → Joint Control Function → Primitive Motion Function
  - (d) Primitive Motion Function → Joint Control Function → Structured Programming Function → Task-oriented Function
- Q13** Sensor are used in work cells for following reasons **EXCEPT**;
- (a) To detect health condition of a worker who operate machine in production line system
  - (b) To detect a condition where a robot or other machine could be harmed by some other manufacturing equipment
  - (c) To monitor the work-cell operation to detect and analyse system malfunction
  - (d) To measure production parts to determine the current level of product quality
- Q14** Vision system are being used with robot automation to perform the following tasks, **EXCEPT**;
- (a) Part identification and orientation
  - (b) Part inspection
  - (c) Part location and range finding
  - (d) Find mass value

- Q15** The PLC is a computer designed for control of manufacturing process, assembly systems and general automation. What 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) The PLC communication modules are not used as frequently as input and output modules
  - (c) Input modules receives electrical signal from PLC processor
  - (d) The output modules are wired to system components that control the process.
- Q16** Most robot for automation application in industry would involve the following categories, **EXCEPT**;
- (a) Material Handling
  - (b) Machine Tending
  - (c) Process
  - (d) Transportation
- Q17** What is the primary advantage of hydraulic actuators?
- (a) A very high power-to-size ratio that affords large load capability
  - (b) Regular testing of the hydraulic fluid is required to determine the wear on actuator
  - (c) Even the best hydraulic system will leak eventually
  - (d) Hydraulic oil can become a fire hazard in arc welding application
- Q18** For non-industrial robot, most invention are suit to hazardous environment, exploration or house chores. Choose the right robot with their application;
- (a) Roomba™ – walks, runs and interact with people.
  - (b) Nao – a robot vacuum cleaner.
  - (c) Robonaut – crawl down the pipe and wash away the sludge with a stream of water.
  - (d) Dante – reach the lava lake of constantly erupting volcano.



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



**Figure 1: Articulated 2-axis robot arm.**

**Q19** Identify D-H parameter of Link 0-1, for the robot arm as in **Figure 1**. Use  $\theta$ ,  $d$ ,  $a$  and  $\alpha$  priority.

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

**Q20** According D-H convention, the following are transformation required **EXCEPT**

- (a) Translate about the  $z_0$ -axis an angle of  $\theta$ , 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  $\alpha$  about the  $x_1$ -axis is zero

**SECTION B**

**Q21** A company wants to produce razor blade for individual usage. There are several type of razor blade such as straight razor, electrical razor, multilayer and etc.

- (a) State any **two (2)** types of automation in manufacturing. (1 mark)
- (b) Choose the type of automation that best suit to set up the manufacturing plan. (1 mark)
- (c) Justify your answer in **Q21(b)**. (8 marks)

**SECTION C**

**Q22** (a) The end-effector, which is mounted on the tool plate is a device used to make intentional contact with an object or to produce the robot's final effect on its surroundings by performing a particular task.

- (i) Classify all types of end-effector into **three (3)** categories. (6 marks)
- (ii) Give an example of end-of-tool mechanism for each category in **Q22(a)(i)**. (3 marks)
- (iii) For each situation below, state the category and gripping mechanism of end-effectors for a robot in completing the task.
  - (1) Lift the multiple layers of plywood sheets one-by-one.
  - (2) Spot welding and screwing nut in cars production line.
  - (3) Insert pin into 5mm diameter hole.(6 marks)

(b) Proximity sensors and photoelectric sensors are grouped into non-contact sensor. **Figure Q22(b)** shows a clear bottle pass by a sensor in production line.

- (i) Suggest type of sensor use in that particular situation. (1 mark)

- (ii) Explain the operation of sensing the bottle by the sensor chosen in **Q22(b)(i)**.

(4 marks)

- (c) Industrial robot is a part of automation system. List **five (5)** characteristics that promote the use of robot to replace human labour in the industrial environment.

(5 marks)

- Q23** (a) A frame {D} has been moved 9 units along  $x$ -axis, and 6 units along  $y$ -axis of the reference frame. Find the new location of the frame.

$$\{D\} = \begin{bmatrix} 0.527 & -0.574 & 0.628 & 5 \\ 0.369 & 0.819 & 0.439 & 3 \\ -0.766 & 0 & 0.643 & 8 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(3 marks)

- (b) A point  $V (3, 5, 7)^T$  is attached to a rotating frame. The frame rotates 45 degree about the  $y$ -axis of the reference frame. Find the new coordinates of the point relative to the reference frame after the rotation.

(4 marks)

- (c) A point  $P$  in space is defined as  ${}^B P = (2, 3, 5)^T$  relative to frame B which is attached to the origin of the reference frame A and is parallel to it. Apply the following transformations and to frame B and find  ${}^A P$ .

- Rotate  $90^\circ$  about  $x$ -axis then
- Rotate  $90^\circ$  about local  $z$ -axis then
- Translate 3 units about  $x$ - axis, 6 units about  $y$ - axis and 5 units about  $z$  – axis

(10 marks)

- (d) A frame W was rotated about the  $y$ -axis  $90^\circ$ , followed by a rotation about  $z$ -axis of  $90^\circ$ , then translated about 5 units along  $x$  –axis. Find the total transformation matrix.

(8 marks)

- END OF QUESTION –

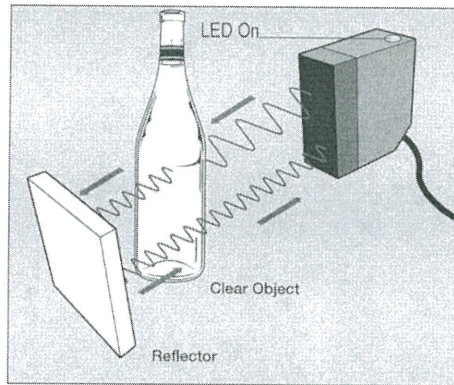


**FINAL EXAMINATION**

SEMESTER/SESSION: SEM I/ 2015/2016

PROGRAMME : 3 DAE

COURSE NAME : ROBOTICS & AUTOMATTION SYSTEM COURSE CODE: DAE 32503



**FIGURE 26 (b)**