First Semester Examination
2021/2022 Academic Session

February/March 2022

EPC431 – Robotic and Automation

Duration : 3 hours

Please check that this examination paper consists of FIVE [5] printed pages before you begin the examination.

INSTRUCTIONS : Answer **ALL FOUR [4]** questions.

In the event of any discrepancies, the English version shall be used.

…2/-

1. [a] State ANY TWO of the Laws of Robots and relate them with benefit gain from the application of robots to;

(i) Increase productivity.
(ii) Reduce labor cost.

(6 marks)

[b] Sketch ANY THREE industrial robot types and describe ANY ONE limitation of each robot for welding application. Please state your assumption.

(4 marks)

2. [a] Explain what are the degree of mobility, degree of steerability and degree of maneuverability. Give ONE (1) example in real application and state the number of degree for the example given.

(30 marks)

[b] Figure 1[a] shows a car-like robot type WMR, derive the kinematic model for world frame and robot frame. State also its non-holonomic constraint and explain the physical meaning of the constraint.

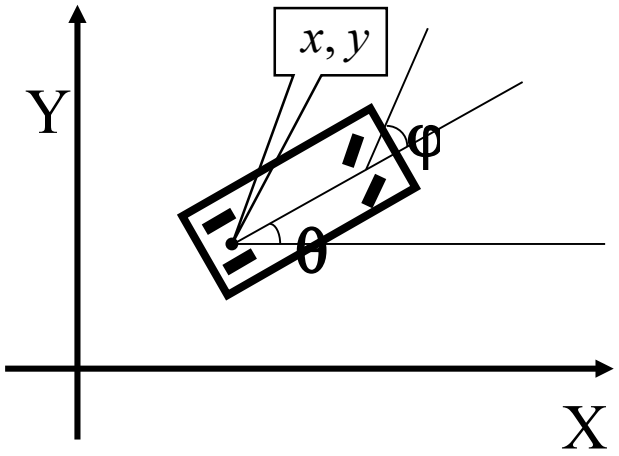

Figure 2[a]

(45 marks)

[c] Suppose that you need to design a WMR for line-following task. What kind of sensor can you suggest to fulfill the task? Sketch the arrangement of the sensor on the WMR.

(25 marks)

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3. [a] (i) State the type of robot arm in Figure 3[a] and draw its workspace.

(15 marks)

(ii) From Figure 3[a], by using inverse kinematics, translate all the Cartesian-coordinates system's axes to the robot's own set of coordinates. Given the current position of the end effector is (150 mm, 245 mm, 100 mm).

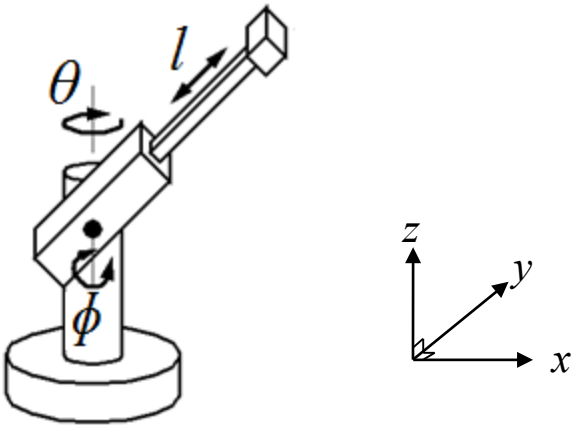

Figure 3[a]

(30 marks)

[b] (i) Assign a coordinate frame of the links shown in Figure 3[b], using right hand rule. Create the D-H link parameters table.

(15 marks)

(ii) Calculate the homogeneous transformation matrices T_{i-1}^{i} by substituting the link parameters from D-H table created in 3[b](i). Determine the overall transformation from the base of the link to its end. The homogeneous transformation matrices is:

$$T_{i-1}^{i} = \begin{bmatrix} C\theta_i & -C\beta_i S\theta_i & S\beta_i S\theta_i & a_i C\theta_i \\ S\theta_i & C\beta_i C\theta_i & -S\beta_i C\theta_i & a_i S\theta_i \\ 0 & S\beta_i & C\beta_i & d_i \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

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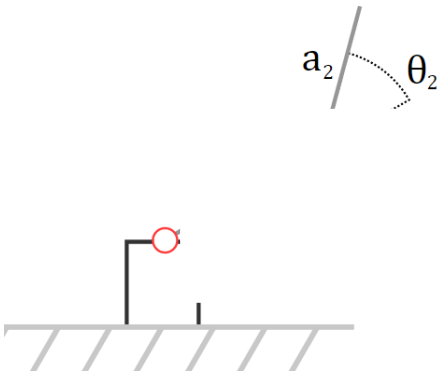

Figure 3[b]

(40 marks)

4. [a] Startrack Industry want to apply a sealant application at their product using fully automation robot system. The detail location of the sealant application was shown in Figure 4[a] which consist of two locations. As a Proses Engineer, what is the main criteria that you must consider for selection of the sealant type in this application?

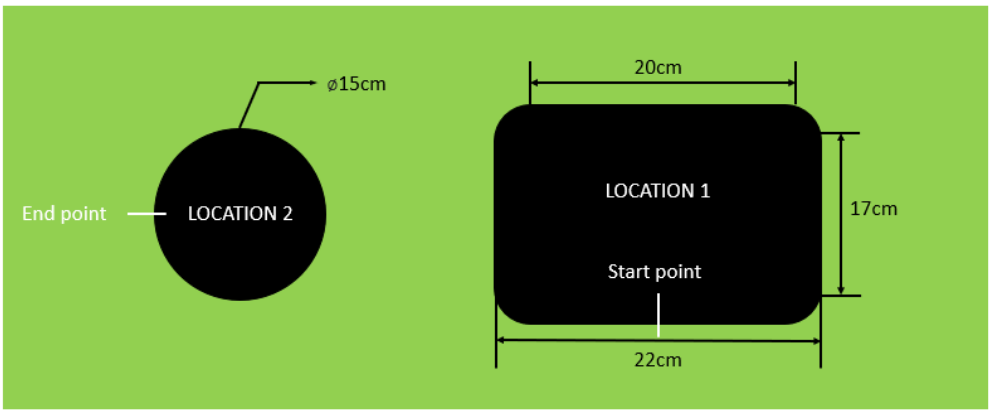

Figure 4[a]

(10 marks)

[b] Sketch the motion of Kuka robot Figure 4[a] to complete the process efficiently. Also included the related point in your sketch.

(10 marks)

[c] Develop a program for Kuka robot for the sealant application process and determine a suitable robot speed if the process needs to be completed within one minute.

(35 marks)

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[d] List down all the components that related for constructing a system as Figure 4[b].

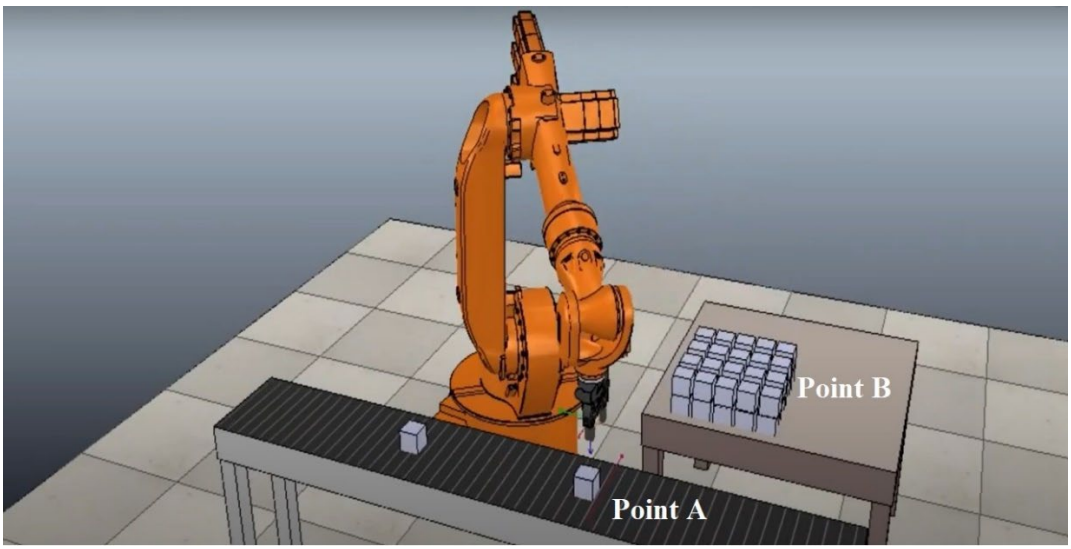

Figure 4[b]

(5 marks)

[e] Develop a program of the Kuka robot for sorting of sixteen blocks (Point B) as Figure 4[b] which is the all the blocks were taken from Point A. The program must consist of execution control, subprograms, and functions to ensure that the proses is completely running.

(30 marks)

[f] After completed sorting the sixteen blocks, it will move automatically to another section to continue for the next process. Decide the suitable speed for robot if the process need to be completed within 4 minutes.

(10 marks)

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