JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -2 EXAMINATION- 2024

B.Tech-VI Semester (ECE)

COURSE CODE(CREDITS): 18B1WEC737 (3) MAX. MARKS: 25

COURSE NAME: ROBOTIC SYSTEMS AND CONTROL

COURSE INSTRUCTORS: Dr Emjee Puthooran MAX. TIME: 1 Hour 30 Minutes

Note: ***(a)*** *All questions are compulsory.*
(b)Marks are indicated against each question in square brackets.
(c) The candidate is allowed to make Suitable numeric assumptions wherever required for solving problems

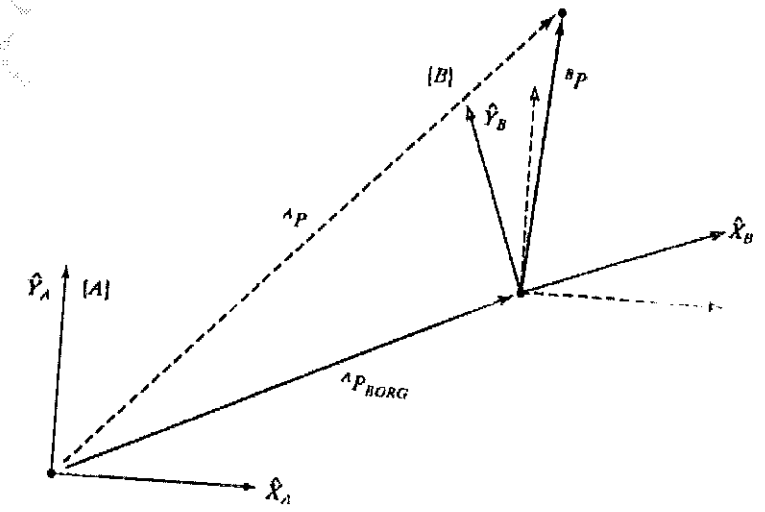
Q1. What is an actuator? Describe the working of a stepper motor. What are the advantages of a stepper motor over a dc motor? [CO2, 2M]

Q2. Describe the concept of degrees of freedom in Robotics. How are they calculated and what do they signify in terms of motion? [CO3, 2M]

Q3. What is the use of an accelerometer and gyroscope for a self-balancing robot? Briefly describe its implementation. [CO2, 3M]

Q4. How do Cartesian, Cylindrical, and Spherical classifications categorize robots based on their coordinate systems? Provide examples of each type and discuss their applications in various industries. [CO3, 3M]

Q5. Figure shows a frame $\{B\}$ that is rotated relative to frame $\{A\}$ about Z axis by 30 degrees, translated 4 units in $\hat{X}_A$, and translated 2 units in $\hat{Y}_A$. Here, $\hat{Z}$ is pointing out of the page. A position vector in frame $\{B\}$ is given by, ${}^{B}P = [1 \quad 3 \quad 0]^{T}$. What is its position vector with respect to frame $\{A\}$? [CO3, 5M]



Q6. It is desired to rotate a position vector ${}^{A}P$ in frame $\{A\}$ about $\hat{Y}_A$ by 30 degrees and translate it 3 units in $\hat{X}$ and 5 units in $\hat{Y}$. Find the operator **T** which can perform the rotation and translation. [CO3, 5M]

Q7. The following frame definitions are given as known:

$$ {}^{U}_{A}T = \begin{bmatrix} 0.866 & -0.500 & 0.000 & 11.0 \\ 0.500 & 0.866 & 0.000 & -1.0 \\ 0.000 & 0.000 & 1.000 & 8.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, $$

$$ {}^{B}_{A}T = \begin{bmatrix} 1.000 & 0.000 & 0.000 & 0.0 \\ 0.000 & 0.866 & -0.500 & 10.0 \\ 0.000 & 0.500 & 0.866 & -20.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}, $$

$$ {}^{C}_{U}T = \begin{bmatrix} 0.866 & -0.500 & 0.000 & -3.0 \\ 0.433 & 0.750 & -0.500 & -3.0 \\ 0.250 & 0.433 & 0.866 & 3.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}. $$

Draw a frame diagram and solve for ${}^{B}_{C}T$. [CO3, 5M]