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PG Diploma MSc. in Electronics and Automation, Semester 3, 2006/2007
MSE304/ME5144 Mechatronics and Robotics

Answer all questions Time allowed: **Two hours**

[Q1]. Background

a. Explain the reasons for increasing demand of factory robotizisation [25]
b. Name robot manipulator types and five major areas robotics applications [25]
c. Describe the singularity problem of serial link robot manipulators [25]
d. Describe the stability issue and "move-and-wait" strategy in space telerobotics [25]

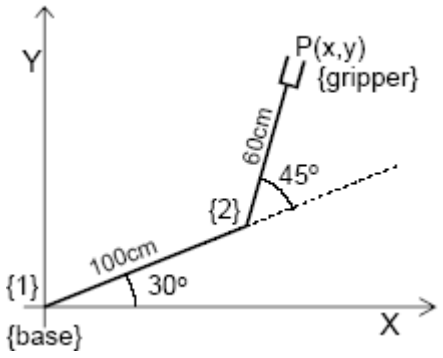
[Q2] Co-ordinate Transformation

{A} and {B} are coincident frames. {B} rotates 30^0 about $\mathbf{z}_A$, 45^0 about $\mathbf{x}_A$,, and then translates to (3, 2, 1) position w.r.t {A}.

a. Find ${}^{A}_{B}T$. [40]
b. A vector ${}^{B}P = [1, 1.5, -3]$ is attached to {B}. Find the position coordinates of ${}^{B}P$ with respect to {A}. [20]
c. Find ${}^{B}_{A}T$ [20]
d. A vector ${}^{A}Q = [1.5, 0, -2]$ is attached to {A}. Find ${}^{B}Q$. [20]

[Q3] Robot Manipulators

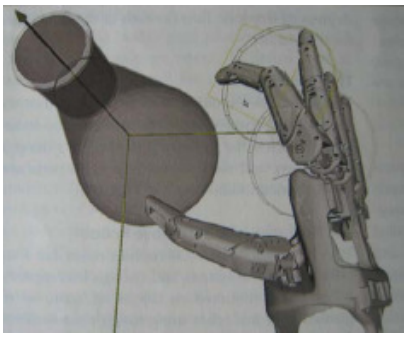
A two-link planner arm is shown below.



(a) Assign co-ordinate frames to {base}, {1}, {2}, and {gripper} [25]
(b) Determine homogeneous transformation matrices ${}^{base}_{1}\mathbf{T}$, ${}^{1}_{2}\mathbf{T}$, and ${}^{2}_{gripper}\mathbf{T}$ [35]
(c) Determine ${}^{base}_{gripper}\mathbf{T}$ and find from it the gripper position and orientation with respect to the {base} [25]
(d) Derive Jacobian ${}^{base}J(\Theta)$ [25]

[Q4] Sensors-based Control

The "reach-and-grasp" task of a robot hand is shown below



(a) List up the required sensors for the robotic hand. And explain how you would selectively use those sensors to reach and grasp the object [25]

(b) Explain how you could detect slippage during grasping [25]

(c) Explain how you could control the contact force just enough to stop slippage [25]

(d) Explain how you could use a qudrature optosensor for speed sensing at high and low speeds [25]