ME38 WMR

# Wheeled Mobile Robots

## Assignment 7

1. A robot is not only a mechanical architecture, but is also slaved by __________ that impacts its performance.
   - ◯ a sensor
   - ◯ a controller
   - ◯ a planner
   - ◯ an actuator
   - ◯ a navigator
   - ◯ a supporter

   Correct answer is **a controller**

2. Seamless integration of inaccurate models and limited sensing capabilities is known as __________
   - ◯ Classical robotics
   - ◯ Probabilistic robotics
   - ◯ Modern robotics
   - ◯ Hybrid robotics
   - ◯ Soft robotics
   - ◯ Field robotics

   Correct answer is **Probabilistic robotics**

3. The inverse differential kinematics or inverse dynamics is equal to __________
   - ◯ a feed-back or closed-loop control
   - ◯ a feed-forward or open-loop control
   - ◯ a motion-based control
   - ◯ a robust control
   - ◯ an adaptive control
   - ◯ an optimal control

   Correct answer is **a feed-forward or open-loop control**

4. Robust control aims at controlling, with a small error, a class of robot manipulators (model is not accurately known) with the same controller.
   - ◯ True
   - ◯ False

   Correct answer is **True**

5. Asymptotically (exponentially) stable means __________
   - ◯ when time tends to infinity, the tracking errors tend to infinity.
   - ◯ when time tends to infinity, the tracking errors tend to be bounded.
   - ◯ when time tends to infinity, the tracking errors tend to zero.
   - ◯ when time tends to zero, the tracking errors tend to infinity.
   - ◯ when time tends to zero, the tracking errors tend to zero.
   - ◯ when time tends to zero, the tracking errors tend to be bounded.

   Correct answer is **when time tends to infinity, the tracking errors tend to zero.**

6. In a set-point or regulatory position control, the desired position vectors and velocity vectors are continuous.

- ◯ True
- ◯ False

Correct answer is **False**

7. The second order error dynamics is stable as per the following condition:
   - ◯ $\ddot{\tilde{\boldsymbol{\eta}}} + \Lambda_1 \dot{\tilde{\boldsymbol{\eta}}} + \Lambda_2 \tilde{\boldsymbol{\eta}} = 0, \Lambda_1 < 0, \Lambda_2 < 0$
   - ◯ $\ddot{\tilde{\boldsymbol{\eta}}} + \Lambda_1 \dot{\tilde{\boldsymbol{\eta}}} + \Lambda_2 \tilde{\boldsymbol{\eta}} = 0, \Lambda_1 < 0, \Lambda_2 > 0$
   - ◯ $\ddot{\tilde{\boldsymbol{\eta}}} + \Lambda_1 \dot{\tilde{\boldsymbol{\eta}}} + \Lambda_2 \tilde{\boldsymbol{\eta}} = 0, \Lambda_1 > 0, \Lambda_2 > 0$
   - ◯ $\ddot{\tilde{\boldsymbol{\eta}}} + \Lambda_1 \dot{\tilde{\boldsymbol{\eta}}} + \Lambda_2 \tilde{\boldsymbol{\eta}} = 0, \Lambda_1 > 0, \Lambda_2 < 0$
   - ◯ $\ddot{\tilde{\boldsymbol{\eta}}} + \Lambda_1 \dot{\tilde{\boldsymbol{\eta}}} - \Lambda_2 \tilde{\boldsymbol{\eta}} = 0, \Lambda_1 > 0, \Lambda_2 > 0$
   - ◯ $\ddot{\tilde{\boldsymbol{\eta}}} - \Lambda_1 \dot{\tilde{\boldsymbol{\eta}}} + \Lambda_2 \tilde{\boldsymbol{\eta}} = 0, \Lambda_1 > 0, \Lambda_2 > 0$

   Correct answer is $\ddot{\tilde{\boldsymbol{\eta}}} + \Lambda_1 \dot{\tilde{\boldsymbol{\eta}}} + \Lambda_2 \tilde{\boldsymbol{\eta}} = 0, \Lambda_1 > 0, \Lambda_2 > 0$

8. The vector of input commands or control inputs of a computed velocity control is given as ($\lambda > 0$):
   - ◯ $\boldsymbol{\zeta} = [\dot{\boldsymbol{\eta}}_d(t) + \lambda \tilde{\boldsymbol{\eta}}(t)]$
   - ◯ $\boldsymbol{\zeta} = [\dot{\boldsymbol{\eta}}_d(t) - \lambda \tilde{\boldsymbol{\eta}}(t)]$
   - ◯ $\boldsymbol{\zeta} = \mathbf{J}^{-1}(\boldsymbol{\eta})[\dot{\boldsymbol{\eta}}_d(t) - \lambda \tilde{\boldsymbol{\eta}}(t)]$
   - ◯ $\boldsymbol{\zeta} = \mathbf{J}^{-1}(\boldsymbol{\eta})[\dot{\boldsymbol{\eta}}_d(t) + \lambda \tilde{\boldsymbol{\eta}}(t)]$
   - ◯ $\boldsymbol{\zeta} = -\mathbf{J}^{-1}(\boldsymbol{\eta})[\dot{\boldsymbol{\eta}}_d(t) - \lambda \tilde{\boldsymbol{\eta}}(t)]$
   - ◯ $\boldsymbol{\zeta} = -\mathbf{J}^{-1}(\boldsymbol{\eta})[\dot{\boldsymbol{\eta}}_d(t) + \lambda \tilde{\boldsymbol{\eta}}(t)]$

   Correct answer is $\boldsymbol{\zeta} = \mathbf{J}^{-1}(\boldsymbol{\eta})[\dot{\boldsymbol{\eta}}_d(t) + \lambda \tilde{\boldsymbol{\eta}}(t)]$

9. The computed input control law of a land-based mobile robot can be given as:
   - ◯ $\boldsymbol{\tau} = \mathbf{D}\left[\left(\ddot{\boldsymbol{\eta}}_d - \dot{\mathbf{J}}(\boldsymbol{\eta}_d)\mathbf{J}^{-1}(\boldsymbol{\eta}_d)\dot{\boldsymbol{\eta}}_d\right) + \mathbf{J}^{-1}(\boldsymbol{\eta})\left(\mathbf{K}_P\tilde{\boldsymbol{\eta}} + \mathbf{K}_D\dot{\tilde{\boldsymbol{\eta}}}\right)\right]$ $+ \mathbf{n}(\boldsymbol{\zeta}_d), \mathbf{K}_P > 0, \mathbf{K}_D > 0$
   - ◯ $\boldsymbol{\tau} = \left[\mathbf{J}^{-1}(\boldsymbol{\eta_d})\left(\ddot{\boldsymbol{\eta}}_d - \dot{\mathbf{J}}(\boldsymbol{\eta}_d)\mathbf{J}^{-1}(\boldsymbol{\eta}_d)\dot{\boldsymbol{\eta}}_d\right) + \mathbf{J}^{-1}(\boldsymbol{\eta})\left(\mathbf{K}_P\tilde{\boldsymbol{\eta}} + \mathbf{K}_D\dot{\tilde{\boldsymbol{\eta}}}\right)\right]$ $+ \mathbf{n}(\boldsymbol{\zeta}_d), \mathbf{K}_P > 0, \mathbf{K}_D > 0$
   - ◯ $\boldsymbol{\tau} = \mathbf{D}\left[\mathbf{J}^{-1}(\boldsymbol{\eta_d})\left(\ddot{\boldsymbol{\eta}}_d - \dot{\mathbf{J}}(\boldsymbol{\eta}_d)\mathbf{J}^{-1}(\boldsymbol{\eta}_d)\dot{\boldsymbol{\eta}}_d\right) + \mathbf{J}^{-1}(\boldsymbol{\eta})\left(\mathbf{K}_P\tilde{\boldsymbol{\eta}} + \mathbf{K}_D\dot{\tilde{\boldsymbol{\eta}}}\right)\right]$ $+ \mathbf{n}(\boldsymbol{\zeta}_d), \mathbf{K}_P > 0, \mathbf{K}_D > 0$
   - ◯ $\boldsymbol{\tau} = \mathbf{D}\left[\mathbf{J}^{-1}(\boldsymbol{\eta_d})\left(\ddot{\boldsymbol{\eta}}_d - \dot{\mathbf{J}}(\boldsymbol{\eta}_d)\mathbf{J}^{-1}(\boldsymbol{\eta}_d)\dot{\boldsymbol{\eta}}_d\right) + \mathbf{J}^{-1}(\boldsymbol{\eta})\left(\mathbf{K}_P\tilde{\boldsymbol{\eta}} + \mathbf{K}_D\dot{\tilde{\boldsymbol{\eta}}}\right)\right]$ $, \mathbf{K}_P > 0, \mathbf{K}_D > 0$
   - ◯ $\boldsymbol{\tau} = \mathbf{D}\left[\mathbf{J}^{-1}(\boldsymbol{\eta_d})\left(\ddot{\boldsymbol{\eta}}_d - \dot{\mathbf{J}}(\boldsymbol{\eta}_d)\mathbf{J}^{-1}(\boldsymbol{\eta}_d)\dot{\boldsymbol{\eta}}_d\right) + \mathbf{J}^{-1}(\boldsymbol{\eta})\left(\mathbf{K}_P\tilde{\boldsymbol{\eta}} + \mathbf{K}_D\dot{\tilde{\boldsymbol{\eta}}}\right)\right]$ $+ \mathbf{n}(\boldsymbol{\zeta}_d), \mathbf{K}_P < 0, \mathbf{K}_D < 0$
   - ◯ $\boldsymbol{\tau} = \left[\mathbf{J}^{-1}(\boldsymbol{\eta_d})\left(\ddot{\boldsymbol{\eta}}_d - \dot{\mathbf{J}}(\boldsymbol{\eta}_d)\mathbf{J}^{-1}(\boldsymbol{\eta}_d)\dot{\boldsymbol{\eta}}_d\right) + \mathbf{J}^{-1}(\boldsymbol{\eta})\left(\mathbf{K}_P\tilde{\boldsymbol{\eta}} + \mathbf{K}_D\dot{\tilde{\boldsymbol{\eta}}}\right)\right]$ $+ \mathbf{n}(\boldsymbol{\zeta}_d), \mathbf{K}_P < 0, \mathbf{K}_D < 0$

   Correct answer is

$$\boldsymbol{\tau} = \mathbf{D}\left[\mathbf{J}^{-1}(\boldsymbol{\eta_d})\left(\ddot{\boldsymbol{\eta}}_d - \dot{\mathbf{J}}(\boldsymbol{\eta}_d)\mathbf{J}^{-1}(\boldsymbol{\eta}_d)\dot{\boldsymbol{\eta}}_d\right) + \mathbf{J}^{-1}(\boldsymbol{\eta})\left(\mathbf{K}_P\tilde{\boldsymbol{\eta}} + \mathbf{K}_D\dot{\tilde{\boldsymbol{\eta}}}\right)\right] + \mathbf{n}(\boldsymbol{\zeta}_d), \mathbf{K}_P > 0, \mathbf{K}_D > 0$$

10. Motion control is a sub-field of ,__________ encompassing the systems or sub-systems involved in moving parts of machines in a controlled manner.
    - ◯ machines
    - ◯ kinematics
    - ◯ processing
    - ◯ navigation
    - ◯ automation
    - ◯ accounting

Correct answer is **automation**

11. What is the primary or important control objective?
    - ◯ tracking performance.
    - ◯ resource optimization.
    - ◯ time optimization
    - ◯ stability.
    - ◯ error minimization.
    - ◯ regulation.

    Correct answer is **stability.**

12. ____________ is the change of state at any instant in time of a body (or bodies). ____________ is thestate of a body or bodies over a period of time. ____________ is the position of a body or bodies over a period of time without worrying about velocity or higher order terms.
    - ◯ Motion, Trajectory, Path.
    - ◯ Path, Motion, Trajectory.
    - ◯ Motion, Path, Trajectory.
    - ◯ Path, Trajectory, Motion.
    - ◯ Trajectory, Motion, Path.
    - ◯ Trajectory, Path, Motion.

    Correct answer is **Motion, Trajectory, Path.**