Module I: Introduction and Review of Basic Concepts

[Lecture: 1, 2, 3]

Quiz I 1. Eigenvalue is associated with

a) Square matrix
b) Matrix of any dimension
c) Row vector
d) Column vector

Quiz I 2. Number of eigenvectors associated with every distinct eigenvalue is

a) One
b) Two
c) Infinite
d) None of these

Quiz I 3. If a square matrix, $A_{n\times n}$ has less than n linearly independent eigenvectors, then it can be transformed by similarity transformation to

a) Diagonal Form
b) Jordan Form
c) Either (a) or (b)
d) None of the above

Quiz I 4. Equivalence transformation can be applied to

a) Square matrix
b) Matrix of any dimension
c) Row/column vectors
d) All of the above

Quiz I 5. Singular value is characteristics of

a) Square matrix
b) Matrix of any dimension
c) Row/column vector
d) All of the above

Quiz I 6. Singular value is always

a) Positive
b) Negative
c) Zero
d) Complex

Quiz I 7. Hessian matrix is always

a) Symmetric
b) Skew-symmetric
c) Diagonal
d) None of the above

Quiz I 8. For a matrix $A_{m\times n}$, where $m > n$, then the rank of A

a) Cannot be more than n
b) Is between m and n
c) Is equal to m
d) Is always equal to n

Quiz I 9. If the rank of matrix $A_{n\times n}$ is n, then it implies that

a) $A_{n\times n}$ has n linearly independent columns
b) $A_{n\times n}$ has n linearly independent rows
c) None (a) or (b)
d) Both (a) and (b)

Quiz I 10. If one of the eigenvalues of a square matrix $A_{n\times n}$ is zero then it implies that

a) Rank of $A_{n\times n}$ is less than n
b) Rank of $A_{n\times n}$ is equal to n
c) Rank of $A_{n\times n}$ cannot be determined
d) None of the above

Quiz I 11. If matrix $A_{n \times n}$ has n distinct eigenvalues then its eigenvectors are

a) Linearly independent
b) Linearly dependent
c) Either (a) or (b) depending on its elements
d) None of the above

Quiz I 12. Numerical differentiation leads to

a) Amplification of noise
b) Reduction of noise
c) Noise is not affected
d) None of the above

Quiz I 13. Numerical integration leads to

a) Amplification of noise
b) Reduction of noise
c) Noise is not affected
d) None of the above

Module II: Static Optimization

[Lecture: 4, 5]

Quiz II 1. Which of the following is true for the sufficient condition for local maximum of $J(x)$ at $x = x^*$ is

a) $\left.\frac{dJ}{dx}\right|_{x=x^*} = 0$
b) $\left.\frac{d^2J}{dx^2}\right|_{x=x^*} > 0$
c) $\left.\frac{d^2J}{dx^2}\right|_{x=x^*} < 0$
d) None of these

Quiz II 2. For $J(x) = x_1^2 - x_2^2$ the point $X = \begin{bmatrix} 0 & 0 \end{bmatrix}^T$ is a

a) Minimum
b) Maximum
c) Saddle
d) None of these

Quiz II 3. The minimum value of the function $J(x) = x_1^2 + x_2^2$ subject to the constraint $x_1 - x_2 = 5$

a) 0
b) 6.25
c) 12.5
d) 15

Quiz II 4. For the function $J(x) = x_1^2 + x_2^2$ subject to the constraints $x_1 - x_2 \le 5$; $x_1 - x_2 \ge 1$ the point

$X = \begin{bmatrix} 0.5 & -0.5 \end{bmatrix}^T$ is a

a) Local minima
b) Global minima
c) Local Maxima
d) Global Maxima

Quiz II 5. For the function $J(x) = x_2 - x_1^{\,2}$ subject to the constraints $1 - x_1^2 - x_2^2 = 0$ the point $X = \begin{bmatrix} 0 & 1 \end{bmatrix}^T$ is a

a) Local minima
b) Global minima
c) Local Maxima
d) Global Maxima

Quiz II 6. Which of the following is true for one of the necessary condition of Kuhn-Tucker condition to minimize $J(X)$ subject to $g_j(X) \le 0$ where λ_j is the Lagrangian multiplier

a) $\lambda_j \le 0$
b) $\lambda_j \ge 0$
c) $\lambda_j < 0$
d) None of these

Quiz II 7. Which of the following is true for the sufficient condition of Kuhn-Tucker condition To maximize $J(X)$ subject to $g_j(X) \le 0$

a) $J(X)$ is strictly convex and all $g_j(X) \le 0$ is convex
b) $J(X)$ is strictly concave and all $g_j(X) \le 0$ is convex
c) $J(X)$ is convex and all $g_j(X) \le 0$ is convex
d) None of these

Module III: Calculus of Variation

[Lecture: 6, 7, 8]

Quiz III 1. Which of the following qualify as functional?

a) $J = \int_0^{t_f} \left(2x(t)^2 + 1\right) dt$

b) $J = \int_0^{t_f} \left(x(t)^2\right) dt$

c) $J = 2t^2 + 5$

d) All of the above

Quiz III 2. Which of the following definition of differential of the function and variation of the functional are true?

a) $\Delta f = \left(\frac{\partial J}{\partial x}\right)\delta x$ & $df = \left(\dot{f}\right)\Delta t$

b) $\Delta f = \left(\frac{\partial J}{\partial x}\right)$ & $df = \dot{f}$

c) $df = \left(\frac{\partial J}{\partial x}\right)\delta x$ & $\Delta f = \left(\dot{f}\right)\Delta t$

d) None of the above

Quiz III 3. For a function $f(t) = t^2 + 2t$ which pair gives the increment (Δf) and derivative (df) of the function $f(t)$.

a) $\Delta f = 2(t+1)\Delta t + (\Delta t)^2$ & $df = 2(t+1)\Delta t$

b) $df = 2(t+1)\Delta t + (\Delta t)^2$ & $\Delta f = 2(t+1)\Delta t$

c) Both are same if Δt is very small and higher order term in Δt are neglected.

d) None of the above.

Quiz III 4. First Variation of the functional $J(x(t)) = \int_0^{t_f} x(t)^2 \, dt$

a) $\delta J = \int_0^{t_f} \left(2x(t)\delta x(t) + \left(\delta x(t)\right)^2\right) dt$

b) $\delta J = \int_0^{t_f} \left(2x(t) + \left(\delta x(t)\right)\right) dt$

c) $\delta J = \int_0^{t_f} \left(2x(t)\delta x(t)\right) dt$

d) None of the above.

Quiz III 5. For relative minima of the functional $J(x(t))$ which of the following is/are true?

a) $\delta J < 0$ & $\delta^2 J > 0$
b) $\delta J \geq 0$ & $\delta^2 J > 0$
c) $\delta J \geq 0$ & $\delta^2 J < 0$
d) None of the above

Quiz III 6. According to fundamental theorem of calculus of variation Euler-Lagrange (E-L) Equation is

a) Sufficiency Condition for optimality.
b) Necessary condition for optimality.
c) E-L equations need not be satisfied for optimality
d) None of the above

Quiz III 7. Which of the following expression is correct expression for E-L equation

a) $\left(\frac{\partial V}{\partial x}\right) - \left(\frac{\partial V}{\partial \dot{x}}\right) = 0$

b) $\left(\frac{\partial V}{\partial x}\right) - \frac{d}{dt}\left(\frac{\partial V}{\partial \dot{x}}\right) = 0$

c) $\left(\frac{\partial V}{\partial \dot{x}}\right) - \frac{d}{dt}\left(\frac{\partial V}{\partial x}\right) = 0$

d) None of the above

Module IV: Classical Numerical Methods

[Lecture: 9]

Quiz IV 1. In shooting method the initial guess value of following is needed?

a) State
b) Control
c) Co-state
d) None of the above

Quiz IV 2. Drawback of shooting method.

a) Selection of initial guess for control is difficult
b) Selection of guess control is complicated
c) Co-state dynamics is generally unstable for stable plant long duration co-state equation propagation is not good
d) Both (a) and (b)

Quiz IV 3. Gradient Method focuses on satisfying

a) $\left(\frac{\partial H}{\partial U}\right) = 0$
b) $\left(\frac{\partial H}{\partial \lambda}\right) = 0$
c) $\left(\frac{\partial H}{\partial X}\right) = 0$
d) None of the above

Module V: Linear Quadratic Regulator (LQR) Theory

[Lecture: 11, 12, 13]

Quiz V 1. For performance index minimization sign of weight on control R should

a) $R \geq 0$
b) $R > 0$
c) $R < 0$
d) $R \leq 0$

Quiz V 2. Select the appropriate choice for condition for optimality of control U

a) $\frac{\partial H}{\partial U} = 0$
b) $\frac{\partial H}{\partial X} = 0$
c) $\frac{\partial H}{\partial \lambda} = 0$
d) $\frac{\partial J}{\partial U} = 0$

Quiz V 3. Which of the following are true in performance index given by

$$J = X^T(t_f)S(t_f)X(t_f) + \frac{1}{2}\int_{t_0}^{t_f}\left(X^TQX + U^TRU\right)dt$$

a) $S(t_f) \geq 0, Q \geq 0$ and $R \geq 0$
b) $S(t_f) > 0, Q > 0$ and $R \geq 0$
c) $S(t_f) \geq 0, Q \geq 0$ and $R > 0$
d) $S(t_f), Q$ can take any sign and $R > 0$

Quiz V 4. Boundary condition on Riccati coefficient P in differential Riccati equation for X_f free condition is.

a) $S(t_f)X(t_f)$
b) $S(t_f)$
c) $X(t_f)$
d) $X(t_f)^T S(t_f)X(t_f)$

Quiz V 5. Which of the following conditions are necessary for stability of LQR solution where $Q = C^T C$

a) Riccati coefficient $P(t)$ must be positive definite
b) $[A, C]$ Pair must be completely observable
c) $[A, B]$ Pair must be completely controllable
d) All of the above

Quiz V 6. Which of the following are true for use of Quadratic cost function

$$J = \frac{1}{2}\int_{t_0}^{t_f}\left(X^T QX + U^T RU\right)dt$$

a) Makes further algebra simple
b) Renders control U Linear in terms of state
c) Both (a) and (b)
d) No specific advantage

Quiz V 7. Optimal value of cost function $J^*(x^*(t),t)$

a) $J^*(x^*(t),t) = 0$
b) $J^*(x^*(t),t) = \frac{1}{2}x^{*T}(t_f)P(t_f)x^*(t_f)$
c) $J^*(x^*(t),t) = \frac{1}{2}x^{*T}(t)P(t)x^*(t)$
d) None of the above

Quiz V 8. The Riccati equation for LQR problem with prescribed degree of stability

a) $PA + A^T P - PBR^{-1}B^T P + Q = 0$
b) $P\left(e^{\alpha t} A\right) + \left(A^T e^{\alpha t}\right)P - PBR^{-1}B^T P + Q = 0$
c) $P\left(A + \alpha I\right) + \left(A^T + \alpha I\right)P - PBR^{-1}B^T P + Q = 0$
d) None of the above

Quiz V 9. For Linear quadratic tracking problem, let $X = \begin{bmatrix} X_T & X_N \end{bmatrix}^T$ where
X_T : are "m" states which track a signal r_c and
X_N : are "n" non tracking states and
$Q = \begin{bmatrix} Q_T & 0_{m\times m} \\ 0_{n\times n} & Q_N \end{bmatrix}$ Q_T, Q_N being the weight on states X_T, X_N respectively.
Then the performance index is defined as.

a) $J = \frac{1}{2}\int_{t_0}^{t_f} \left(X^T Q X + U^T R U\right) dt$
b) $J = \frac{1}{2}\int_{t_0}^{t_f} \left(X_T{}^T Q_T X_T + X_N{}^T Q_N X_N + U^T R U\right) dt$
c) $J = \frac{1}{2}\int_{t_0}^{t_f} \left(\begin{bmatrix} X_T - r_c \\ X_N \end{bmatrix}^T Q \begin{bmatrix} X_T - r_c \\ X_N \end{bmatrix} + U^T R U\right) dt$
d) None of the above

Quiz V 10. LQR solution of systems with parameter inaccuracy the robustness of the controller is ensured because.

a) ∂p is identified and used in final control expression
b) Control $U(t)$ is independent of p or ∂p
c) Due to integral feedback term
d) None of the above

Module VII: Overview of Flight Dynamics

[Lecture: 15, 16, 17]

Quiz VII 1. Steady and constant level flight with zero angle of attack is attained when The

a) Lift balances the weight
b) Thrust balances weight
c) Thrust balances the drag
d) Both (a) and (c)

Quiz VII 2. Rolling motion is created by applying

a) Symmetric deflection in the same direction of the ailerons
b) Differential force on the ailerons
c) Rotation about Z-axis due to rudder deflection
d) None of the above

Quiz VII 3. In tailless aircrafts the combination of elevator and ailerons is known as

a) Rudder
b) Spoiler
c) Elevons
d) Flaps

Quiz VII 4. Coefficient of lift (C_L) at zero angle of attack is zero for

a) Cambered airfoil
b) Symmetric airfoil
c) Both (a) and (b)
d) Neither (c) and (d)

Quiz VII 5. Force balance equations give the

a) Translational dynamics
b) Rotational dynamics
c) Longitudinal dynamics
d) Lateral dynamics

Quiz VII 6. Longitudinal motion is mainly controlled using

a) Rudder
b) Elevators
c) Ailerons
d) None of the above

Quiz VII 7. Phugoid mode of a stable aircraft is typically

a) Undamped
b) Lightly damped
c) Heavily damped
d) Critically damped

Quiz VII 8. Directional motion is mainly controlled by

a) Rudder and ailerons
b) Rudder and elevators
c) Rudder
d) Flaps

Quiz VII 9. Lateral dynamic instabilities are controlled by

a) Rudder and elevators
b) Ailerons and flaps
c) Elevator and ailerons
d) Rudder and ailerons

Quiz VII 10. Choose the correct statement

a) Moments about the aerodynamic centre is constant with varying angle of attack
b) Moments about the centre of gravity is constant with varying angle of attack
c) The centre of pressure location does not vary with angle of attack
d) Both (a) and (c)

Quiz VII 11. For longitudinal stability

a) Aircraft centre of gravity should be ahead of the aerodynamic centre
b) Aircraft centre of gravity should be behind the aerodynamic centre
c) Aircraft centre of gravity should lie on the aerodynamic centre
d) Location of the centre of gravity does not matter

Module IX: State Dependent Riccati Equation and θ – D Designs

[Lecture: 19]

Quiz IX 1. For SDRE design out of three necessary conditions which of the condition is always satisfied (or asymptotically)

a) $\dot{\lambda} = -\left(\dfrac{\partial H}{\partial X}\right)$

b) $\dfrac{\partial H}{\partial U} = 0$

c) $\dot{X} = \left(\dfrac{\partial H}{\partial \lambda}\right)$

d) Both (a) and (b)

Quiz IX 2. If $A_1(X)$ and $A_2(X)$ are two SDC parameterizations, then another SDC parameterization can be constructed as

a) $\alpha(X)A_1(X) + [1-\alpha(X)]A_2(X), \quad 0 \le \alpha(X) \le 1$

b) $\alpha(X)A_1(X) + [1-\alpha(X)]A_2(X), \quad \alpha(X) \ge 1$

c) $[1-\alpha(X)]A_1(X) + \alpha(X)A_2(X), \quad 0 \le \alpha(X) \le 1$

d) Both (a) and (c)

Quiz IX 3. Quiz X.3 For the function $f(x) = \cos x$ the SDC parameterization is

a) $\left(\dfrac{\cos x}{x}\right)x$

b) $\left(\dfrac{\cos x - 1}{x}\right)x + 1$

c) $1 - \left(\dfrac{x}{2!} - \dfrac{x^3}{4!}\right)x$

d) None of these

Quiz IX 4. Which of the statement is not true about SDRE design

a) Can directly handle unstable and/or nonminimum phase system
b) Can preserve beneficial nonlinearities
c) Cannot be used to design servo systems
d) Can incorporate hard bound on state and control

Quiz IX 5. $\theta - D$ method solves

a) Riccati equation online
b) Riccati equation offline
c) A set of Lyapunov equations online
d) A set of Lyapunov equations offline

Module X: Dynamic Programming and Adaptive Critic Design

[Lecure: 20, 21]

Quiz X 1. Bellman's principle of optimality simply states that any portion of the optimal Trajectory is

a) Suboptimal
b) Not optimal
c) Optimal
d) None of these

Quiz X 2. The Hamilton-Jacobi-Bellman (HJB) equation is defined as

a) $\frac{\partial V}{\partial t} + H = 0$
b) $\frac{\partial V}{\partial t} + H_{opt} = 0$
c) Both (a) and (b)
d) None of these

Quiz X 3. For the optimal cost function the HJB equation is

a) Necessary and sufficient
b) Necessary
c) Sufficient
d) None of these

Quiz X 4. SNAC is computationally faster compare to AC because of

a) Elimination of training of action networks
b) Elimination of iterative training between action and critic networks
c) Both (a) and (b)
d) None of the above

Quiz X 5. For the Approximate dynamic programming costate equation on optimal path is obtained as

a) $\lambda_k = \frac{\partial \psi_k}{\partial X_k} + \left(\frac{\partial X_{k+1}}{\partial U_k} \right)^T \lambda_{k+1}$

b) $\lambda_k = \frac{\partial \psi_k}{\partial X_k} + \left(\frac{\partial X_{k+1}}{\partial X_k} \right)^T \lambda_{k+1}$

c) $\lambda_k = \frac{\partial X_{k+1}}{\partial X_k} + \left(\frac{\partial \psi_k}{\partial X_k} \right)^T \lambda_{k+1}$

d) None of these

Quiz X 6. For the problem minimize

$J = \frac{1}{2} \int_0^{t_f \to \infty} \left(x^2 + u^2 \right) dt$ subject to $\dot{x} = -x^3 + u,\ x(0) = x_0$ the optimal control is

a) $u_{opt} = x^3 + \sqrt{x^6 + x^2}$

b) $u_{opt} = x^3 - \sqrt{x^6 - x^2}$

c) $u_{opt} = x^3 - \sqrt{x^4 + x^2}$

d) $u_{opt} = x^3 - \sqrt{x^6 + x^2}$

Quiz X 7. For the problem minimize

$J = \frac{1}{2} \int_0^{t_f} \left(x^2 + u^2 \right) dt$ subject to $\dot{x} = -x^3 + u,\ x(0) = x_0$ the optimal control is

a) $u_{opt} = -x + x^3$

b) $u_{opt} = x^3 - \sqrt{x^6 - x^2}$

c) None of these

d) Difficult to solve

Quiz X 8. For the problem minimize

$$J = \frac{1}{2}\int_0^{t_f \to \infty} \left(x^2 + u^2\right) dt$$ subject to $\dot{x} = -x^3 + u,\ x(0) = x_0$ the optimal control is

a) $u_{opt} = -\left(x - x^3\right) - \sqrt{\left(1 - x^2\right)^2 + 1}$

b) $u_{opt} = -\left(x - x^3\right) + x\sqrt{\left(1 - x^2\right)^2 + 1}$

c) $u_{opt} = -\left(x - x^3\right) - x\sqrt{\left(1 - x^2\right)^2 + 1}$

d) $u_{opt} = -\left(x - x^3\right) - x\sqrt{\left(1 - x^2\right)^2}$

Module XI: Advanced Numerical Techniques for Optimal Control

[Lecture: 22, 23, 24, 25]

Quiz XI.1. Multiple shooting method philosophy of the transcription method requires which of the following constraints on the intermediate grid points

a) Continuity of the state value at the grid points
b) Slope of the state profile should match at the grid points
c) Both (a) and (b)
d) No such restrictions are needed at the grid points

Quiz XI.2. Which of the following options are true regarding transcription method philosophy

a) Dynamics is handled in continues domain along with static optimization techniques
b) Discrete Dynamics is used with dynamic optimization techniques
c) Equivalent static optimization problem is posed for a discretized dynamic system
d) None of the above

Quiz XI.3. Choose the appropriate argument for selection of test function $\chi_n = \delta(t - t_n)$ in pseudospectral transcription method

a) This selection simplifies the inner product of the two continues function $\langle \chi_n, R \rangle$
b) The inner product $\langle \chi_n, R \rangle$ gives residue at each point t_n, where $n = 1, 2 \ldots N$
c) $\chi_n = \delta(t - t_n)$ is a arbitrary selection
d) None of the above

Quiz XI.4. Choose the appropriate option, in descending order of accuracy of selection method of the collocation point for pseudospectral transcription method

a) Gauss Radau, Gauss, uniform, Gauss Lobatto
b) Gauss Lobatto, Gauss Radau, Gauss, Uniform
c) Uniform, Gauss, Gauss Radau, Gauss Lobatto
d) Uniform, Gauss Radau, Gauss, Gauss Lobatto

Quiz XI.5. In pseudospectral method the approximation of the state vector $\hat{X}$ is chosen such as to minimize which of the following residual norm

a) $\|R\| = \|\hat{X} - X\|$
b) $\|R\| = \|\dot{\hat{X}} - f\|$
c) Both (a) and (b)
d) None of the above

Quiz XI.6. Choose appropriate option/s for merits of the Model predictive static programming control philosophy

a) No Approximation of the system Dynamics
b) Terminal constraints are met as hard constraints
c) Provides are closed form control expression
d) Both (a) and (b)

Quiz XI.7. Which of the following argument are true for sensitivity matrix B_k

a) Sensitivity matrix gives the information of final time output deviation (ΔY_N) for every small control deviation dU_k at each time step $k = 1, 2 \cdots N-1$
b) B_k can be calculated recursively
c) $\sum_{k=1}^{N-1} B_k dU_k = dY_N$ forms a under constrained problem and one can aim at meeting additional objectives
d) All of the above

Quiz XI.8. Which are true for Guess control history for MPSP method

a) Should be a stabilizing control solution
b) Any control history can be considered
c) Zero control
d) Must be judiciously selected depending on the problem statement.
e) None of the above

Quiz XI.9. Optimal control for MPSP method with augmented cost function is defined as

a) $\dfrac{\partial \bar{J}}{\partial U_k} = 0$

b) $\dfrac{\partial \bar{J}}{\partial dU_k} = 0$

c) $\dfrac{\partial \bar{J}}{\partial (U_k - dU_k)} = 0$

d) None of the above

Quiz XI.10. In MPSP control derivation the quantity dX_1 is taken zero, which of the following reason are true

a) dX_1 is small quantity and hence neglected

b) X_1 is deterministic and dX_1 is undefined

c) dX_1 is the deviation at time t_0 or $k = 1$. Since initial conditions are specified and there is no error in first term

d) None of the above

Quiz XI.11. Choose the appropriate choices for merits of MPSP over ADP is/are

a) Formulation is simple
b) No approximation of system dynamics
c) Dynamic optimization is converted to static optimization where costate λ is constant
d) All of the above

Module XII: LQ Observer and Kalman Filter Design

[Lecture: 26, 27, 28, 29, 30]

Quiz XII.1. The necessary and sufficient condition for the existence of the observer Gain

a) The system should be controllable
b) The system should not be controllable
c) The system should not be observable
d) The system should be observable

Quiz XII.2. Which of the following is true for the Kalman filter

a) Kalman filter is a band filter circuit
b) Kalman filter is a high-pass filter circuit
c) Kalman filter is a low-pass filter circuit
d) Kalman filter is an algorithm

Quiz XII.3. Initial value of error covariance matrix

a) Does not affect steady state estimation accuracy
b) Does affect the convergence time
c) Does not affect on performance
d) None of these

Quiz XII.4. Which are the correct assumptions of Kalman filter

a) $X(0) \sim \left(\tilde{X}_0, P_0\right),\ w(t) \sim \left(0, Q\right)$ and $v(t) \sim \left(0, R\right)$ are mutually orthogonal
b) $w(t)$ and $v(t)$ are uncorreleted white noise
c) Q is Positive semi definite and R is Positive definite
d) All of the above

Quiz XII.5. In Kalman filter, gain at any time

a) Depend on current state
b) Depend on current measurement
c) Independent on current state and measurement
d) None of these

Quiz XII.6. In Kalman filter, gain

a) Should be high if measurement noise is less
b) Should be high if initial state error are high
c) Should be low if state model is perfect
d) All of these

Quiz XII.7. In Kalman Filter, the value of state covariance matrix Q

a) Value of Q high mean in state
b) Value of Q high help in convergence of estimate
c) Q have no effect on convergence
d) If state model is perfect then Q should be small

Quiz XII.8. In Kalman filter, gain

a) Increase if value of P increases
b) Increase if value of Q increases
c) Increase if value of R decreases
d) All of above

Quiz XII.9. In Kalman filter

a) Observability condition should be satisfied
b) Controllability condition should be satisfied
c) Detect ability condition is sufficient
d) None of these

Quiz XII.10. Which of the following is true for the Kalman filter

a) The initial condition of the state, process noise and measurement noise are mutually orthogonal
b) The process noise and measurement noise are uncorrelated white noise
c) The process noise covariance matrix is positive-semi definite
d) The measurement noise covariance matrix is positive-semi definite

Quiz XII.11. Which of the following is Not true for the continuous-discrete time Kalman filter design

a) It works based on the continuous-time prediction and discrete-time correction mechanism
b) It is practically useful because the measurement is available at discrete-time steps
c) It facilitates only the usage of uniform time-step
d) All the above

Quiz XII.12. Which of the following is Not true for the Extended Kalman filter (EKF) Design

a) The EKF is a cure for every nonlinear system
b) Linearization can introduce significant error
c) The EKF is not truly optimum
d) No general convergence is guaranteed

Quiz XII.13. Which of the following is true for the Kalman filter (KF) design of nonlinear systems

a) KF design of nonlinear systems works like the KF design of linear systems
b) KF design of nonlinear systems (like EKF) is truly optimum
c) The Gaussian input of the nonlinear system does not always produce a Gaussian output
d) None of these

Module XIII: Integrated Estimation, Guidance and Control

[Lecture: 31, 32]

Quiz XIII.1. Partial Integrated guidance and control (PIGC) operates in two loop structure which is as follows

a) Commanded latax and body rates are generated in outer and inner loop respectively
b) Commanded body rates and fin deflections are generated in outer and inner loop respectively
c) Commanded fin deflections and body rates are generated in outer and inner loop respectively
d) None of these

Quiz XIII.2. Nonlinear control design approaches are evolving but are seldom used because of

a) They takes lot of effort and tuning to make it work
b) They don't have good robustness evaluation tools
c) Sometimes they become over conservative (sluggish)
d) Both (b) and (c)

Quiz XIII.3. The major advantages and drawbacks of Single loop IGC design are

a) Works very well for large perturbations about the collision triangle
b) Design tuning is very difficult
c) Control attempts to alter the translational dynamics directly
d) Both (b) and (c)

Quiz XIII.4. The Integrated Estimation and Guidance (IEG) uses the following in the estimation process

a) Time to go only
b) ZEM only
c) Time to go as well as ZEM
d) None

Quiz XIII.5. In PIGC

a) Body rates are output of PIGC
b) Fin deflections are output of PIGC
c) Acceleration demands are output of PIGC
d) None of these

Quiz XIII.6. In IGC

a) Control and Guidance work in synergy for a common goal
b) Subsystem weight like actuator can be reduces
c) Control demand can be reduced for the same performance
d) Fin deflections are the output of IGC

Module XIV: Linear Quadratic Guassian Design

[Lecture: 33]

Quiz XIV.1. Problem of LQG design is

a) Loss of controllability
b) Loss of observability
c) Loss of robustness
d) None of these

Quiz XIV.2. The neighboring optimum paths exist in a weak sense, if $\left[P(t)-R(t)Q^{-1}(t)R^{T}(t)\right]$ is finite and

a) $H_{UU}(t)<0$ and $\mathrm{Q}(\mathrm{t})<0$
b) $H_{UU}(t)<0$ and $\mathrm{Q}(\mathrm{t})>0$
c) $H_{UU}(t)>0$ and $\mathrm{Q}(\mathrm{t})>0$
d) $H_{UU}(t)>0$ and $\mathrm{Q}(\mathrm{t})<0$

Module XV: Constrained Optimal Control

[Lecture: 34, 35, 36]

Quiz XV.1. Necessary condition/conditions for constrained control problem is/are

a) $\dot{\lambda} = -\left(\dfrac{\partial H}{\partial X}\right)$
b) $\dfrac{\partial H}{\partial U} = 0$
c) $H\left(X,\ U^*,\ \lambda\right) \leq H\left(X,\ U,\ \lambda\right)$
d) Both (a) and(c)

Quiz XV.2. If the final time is fixed and the Hamiltonian (H) does not depend on time explicitly, then along the optimal trajectory

a) $H\left(X^*, U^*, \lambda^*\right) = \text{Constant}$
b) $H\left(X^*, U^*, \lambda^*\right) = 0$
c) Can't say
d) None of these

Quiz XV.3. If the final time is free and the Hamiltonian (H) does not depend on time explicitly, then along the optimal trajectory

a) $H\left(X^*, U^*, \lambda^*\right) = \text{Constant}$
b) $H\left(X^*, U^*, \lambda^*\right) = 0$
c) Can't say
d) None of these

Quiz XV.4. For NTOC system if all the $n+1$ eigenvalues of the system are real, then U^*switch from +1 to -1 or vice versa at most

a) $n-1$ times
b) n times
c) $n+1$ times
d) $n+2$times

Quiz XV.5. The neighboring optimum paths exist in a weak sense, if $\left[P(t)-R(t)Q^{-1}(t)R^{T}(t)\right]$ is finite and

a) $H_{UU}(t)<0$ and $\mathrm{Q}(\mathrm{t})<0$

b) $H_{UU}(t)<0$ and $\mathrm{Q}(\mathrm{t})>0$

c) $H_{UU}(t)>0$ and $\mathrm{Q}(\mathrm{t})>0$

d) $H_{UU}(t)>0$ and $\mathrm{Q}(\mathrm{t})<0$

Module XVI: Optimal Control of Distributed Parameter Systems

Quiz XVI.1. System dynamics truncation philosophy is utilized in which of the following control method of Distributed parameter systems

a) Approximate and Design
b) Design and Approximate
c) Both (a) and (b)
d) None of the above

Quiz XVI.2. Optimal Nonlinear Dynamic Inversion solution for distributed parameter systems, which of the arguments is/are true for control U

a) As $X \rightarrow X^* : U \rightarrow 0$
b) As $X \rightarrow X^* : U \rightarrow U^*$
c) As $X \rightarrow X^*$ there is no particular bound on control U
d) None of the above

Quiz XVI.3. For class of diffusion problem with linear initial profile $x(0, y)$, which of the following arguments are true regarding the solution accuracy of the problem

a) Dependent on the number of grid points on the spatial domain
b) Independent of the grid points since the spatial derivative of the initial profile is constant/zero
c) Dependent on the grid points up to some extent and then invariant with further increase of number of grid points
d) None of the above

Quiz XVI.4. For discrete actuator case of the Optimal Nonlinear Dynamic Inversion solution for distributed parameter systems, a modified discrete point error dynamics $\dot{E}+KE$ is considered to solve which of the following short comings

a) Resulting continues control from continues actuator case is difficult to implement
b) Singularity in the control for the special case where weight on the control actuation $\left[r_1 \quad r_2 \ldots r_{M-1} \quad r_M\right]$ and grid point width $\left[w_1 \quad w_2 \ldots w_{M-1} \quad w_M\right]$, are selected such that $r_1 w_1 = r_2 w_2 = \ldots = r_M w_M$
c) Both (a) and (b)
d) None of the above

Quiz XVI.5. In SNAC Solution of the distributed parameter systems, which of the following arguments are true regarding state profile generated for Neural Network training

a) State profile need to be continues
b) State profile need to be continues and bounded
c) Need to be bounded but need not be continues
d) None of the above

Quiz XVI.6. Which of the following philosophy are used to generate the state profile for NN training for SNAC solution of distributed parameter systems

a) Bound on L_∞ norm
b) Bound on L_2 norm
c) Bound on the total Energy content of the systems
d) All of the above