

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)**

CLASS: MTECH  
BRANCH: ECE

SEMESTER : II  
SESSION : SP/2025

**SUBJECT: EC523 DETECTION AND ESTIMATION THEORY**

TIME: 3 Hours

FULL MARKS: 50

**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
  2. Attempt all questions.
  3. The missing data, if any, may be assumed suitably.
  4. Before attempting the question paper, be sure that you have got the correct question paper.
  5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
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Q.1(a) Diagonalize Matrix A and justify your answer [5] CO 1 BL 3

$$A = \begin{bmatrix} -1 & -19 & -4 \\ 0 & -2 & 0 \\ 0 & 15 & 3 \end{bmatrix}$$

Q.1(b) Determine the value of 'b' for matrix P to be positive semidefinite and justify your answer [5] 1 3

$$P = \begin{bmatrix} 2 & -1 & b \\ -1 & 2 & -1 \\ b & -1 & 2 \end{bmatrix}$$

Q.2(a) Define alternative Hypothesis. Using Lagrangian multipliers derive an expression to decide alternative hypothesis based on Neyman Pearson theorem. [5] 2 3

Q.2(b) Derive an expression to evaluate Minimum Bayes Risk in Multiple Hypothesis scenario. Compare Probability of False Alarm and Probability of missed detection. [3+2] 2 3

Q.3(a) Explain Optimum Filter [5] 3 2

Q.3(b) In the presence of AWGN derive an expression for Matched filter. Compare the Matched filter with an Optimum filter. [5] 3 3

Q.4(a) Derive an expression to evaluate the maximum likelihood estimate of unknown parameter 'h' for Maximum Likelihood Estimator (MLE). Also prove that MLE is an 'unbiased estimator'. [5] 4 3

Q.4(b) Derive an expression to evaluate mean and variance for non-zero mean Minimum Mean square error (MMSE). Also evaluate the lower bound for MMSE. [5] 4 3

Q.5(a) With the help of suitable block diagram explain Kalman Filter [5] 5 2

Q.5(b) For Kalman Filter design, determine the Kalman gain and current estimate, if the true temperature values are 75, error in estimate is 3 previous estimate is 65 measured values are 78, 75, 71 and 70, error in measurement is 3. Show calculation for at least 4 stages. [5] 5 3

:::26/04/2025 E:::