2012-2013  
M.TECH (III SEMESTER) EXAMINATION  
(ELECTRICAL ENGG)  
Course No. EE-744  
Stochastic Control System

Maximum Marks: 60  
Duration: Three Hours

"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised".

Note:  
(i) Attempt all questions.  
(ii) Assume any suitable data, if missing.  
(iii) Symbols have their usual meanings.

Q1  
(a) Discuss the relative frequency approach to probability.  

(b) Random variables X and Y have the joint density function

\[ f_{X,Y}(x,y) = \begin{cases} 
\frac{(x+y)^2}{40} & -1 < x < 1 \text{ and } -3 < y < 3 \\
0 & \text{elsewhere} 
\end{cases} \]

(i) Find all the second-order moments of X and Y.

(ii) What are the variances of X and Y?

(iii) What is the correlation coefficient?

OR

Q1'  
(a) If A, B and C are independent events, prove that the following are also independent:

i. A and B ∪ C.

ii. A and B - C.

(b) An electronic manufacturer uses four different types of ICs in manufacturing a particular device. The NAND gates (designated as G if good and \( \overline{G} \) if bad) have a probability of 0.05 of being bad. The flip flops (F and \( \overline{F} \)) have a probability of 0.1 of being bad, the counters (C and \( \overline{C} \)) have a probability of 0.03 of being bad, and the shift registers (S and \( \overline{S} \)) have a probability of 0.12 of being bad.

i. Write all of the elements in the product space.

ii. Determine the probability that the manufactured device will work.

iii. If a particular device does not work, determine the probability that only the flip flops are bad.

iv. If a particular device does not work, determine the probability that both the flip flops and the counters are bad.
Q2  (a) Define the autocorrelation function and discuss its properties for random processes.

(b) Define two random processes by \(X(t) = p_1(t + \varepsilon)\) and \(Y(t) = p_2(t + \varepsilon)\) when \(p_1(t)\) and \(p_2(t)\) are both periodic waveforms with period \(T\) and \(\varepsilon\) is a random variable uniformly distributed on the interval \((0,T)\). Find an expression for the cross correlation function \(E[X(t)Y(t + \tau)]\)

Q3 Define Power Spectral Density and its properties

OR

Q3' A random process is given by \(W(t) = A \cdot X(t) + B \cdot Y(t)\), where \(A\) and \(B\) are real constants and \(X(t)\) and \(Y(t)\) are jointly wide-sense stationary processes:

i. Find the power spectrum \(S_{XX}(\omega)\) of \(W(t)\)

ii. Find \(S_{XX}(\omega)\) if \(X(t)\) and \(Y(t)\) are uncorrelated.

iii. Find the cross-spectrums \(S_{XW}(\omega)\) and \(S_{YW}(\omega)\)

Q4  (a) List the properties of correlation matrix of a stationary discrete time stochastic process.

OR

(a') Describe the auto-regressive model of order 'M'. Solve this model using Yule-Walker equations.

(b) For an AR process \(u[n]\) of model order 2, the difference equation is as follows:
\[
ue(n) - 0.3 \cdot ue(n-1) + 0.8 \cdot ue(n-2) = v(n)
\]

Use the Yule-Walker equations to find the autocorrelation and variance for the process \(u(n)\).

\(v(n)\) is a white noise process with zero-mean and variance as 0.4.

Q5  (a) Describe the Wiener-Hopf equations to specify the optimum filter coefficients in terms of correlation functions.

(b) Let the tap input vector of a transversal filter be defined by
\[
uu(n) = \alpha(n) \cdot s(n) + v(n),\] with \(\alpha(n)\) uncorrelated with \(v(n) = [v(n)n, v(n-1), v(n-2), ...
\)
\(v(n-M+1)]^T\) and \(\sigma^2 = E[|\alpha(n)|^2]\), \(s(n) = [1, \exp(-j\omega), ..., \exp(-j\omega(M-1))]^T\)

(i) Determine the correlation matrix of the tap input vector \(u(n)\).

(ii) If desired response \(d(n)\) is uncorrelated with \(u(n)\), find the tap weight vector.

(iii) If \(\sigma^2 = 0\) and desired response is \(d(n) = v(n-k)\), where \(0 \leq k \leq M-1\). Find the tap weight vector of the Wiener filter.
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<table>
<thead>
<tr>
<th>S. No. of Questions</th>
<th>Instruction to the Examinees: “Students governed by the old ordinance will be examined out of 75 marks and their obtained marks shall be proportionately raised.”</th>
<th>Marks allotted</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Answer <strong>five questions</strong> only. All questions have equal marks. Assume any suitable value to missing data. Symbols used have their usual meaning.</td>
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<tr>
<td>Q 1(a)</td>
<td>What do you mean by R/P ratio? Name the top three coal exporting countries in the World. Sketch the R/P ratio (for 2011 by region) for Asia pacific, Middle East and North America.</td>
<td>6</td>
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<td>(b)</td>
<td>What is OPEC and When it was formed? Give the aims &amp; objectives of its formation. Discuss in brief the oil crisis of 1973 and its aftereffects.</td>
<td>6</td>
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<td>Q 2(a)</td>
<td>How waves are created? Give the major factors that effect the wave formation.</td>
<td>4</td>
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<tr>
<td>(b)</td>
<td>Classify the wave devices based on location of installation from the shore. Describe with neat sketch TAPCHAN wave device for power generation. Discuss in brief the Indian potentials of wave energy.</td>
<td>8</td>
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<tr>
<td>Q 3(a)</td>
<td>Give the technical analysis of OTEC systems and variation of temperature with Ocean depth. Give the reasons for difference in actual and ideal efficiencies of OTEC systems.</td>
<td>6</td>
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<tr>
<td>(b)</td>
<td>Discuss the important benefits of OTEC other than power production.</td>
<td>6</td>
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<td>Q 4(a)</td>
<td>Discuss in details the solar power system specially designed for houses in rural areas.</td>
<td>4</td>
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<tr>
<td>(b)</td>
<td>Classify the solar cells based on the generation and compare their costs and efficiencies.</td>
<td>4</td>
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<tr>
<td>(c)</td>
<td>Give a brief note for (i) Polymer solar cells (ii) Multijunction solar cells.</td>
<td>4</td>
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*contd...*
| Q 5(a) | What are RTG’s and where they have been used? | 4 |
| Q 5(b) | Write short notes on TEG’s for: (i) hot water pots (ii) lantern for camping. | 4 |
| Q 5(c) | Discuss the thermoelectric cooling and give its advantages and disadvantages. | 4 |
| Q 6(a) | Explain the term thermion and discuss the principle of thermionic converters. | 4 |
| Q 6(b) | Describe the Micro Fabricated Thermionic Energy Converters. | 4 |
| Q 6(c) | State the applications of thermionic converters. | 4 |
| Q 7(a) | Classify MHD generators based on geometry and cycle of operation. | 2 |
| Q 7(b) | With a neat sketch describe the working principles of inertial type Liquid Metal MHD generator. | 4 |
| Q 7(c) | Give the important Applications of MHD generators. | 2 |
| Q 7(d) | With the following specifications for an MHD generator, Calculate the open circuit voltage, resistance Rg, total power output and maximum power per unit volume.  
Plate area (A) = 0.5 m²  
Distance between plates, (d) = 0.3 m  
Flux density (B) = 3 Wb/m²  
Ave. Gas Velocity (μ) = 10³ m/s  
Gas Conductivity (σ) = 100 Mho/m | 4 |