2015-2016
M.TECH. AUTUMN (I SEMESTER) EXAMINATION
(ELECTRONICS ENGINEERING)
COMMUNICATION & INFORMATION SYSTEM/
ELECTRONIC CIRCUITS & SYSTEM DESIGN
ADVANCE MATHEMATICS
[AM – 651]

Max Marks: 60

Duration: Three Hours

Note: Answer any five questions by selecting at least two questions from each section.

SECTION ‘A’

1. (a) Suppose that the following table represents the joint probability distribution of the discrete random variable (x, y)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/12</td>
<td>1/6</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1/9</td>
<td>1/5</td>
</tr>
<tr>
<td>3</td>
<td>1/18</td>
<td>1/4</td>
<td>15</td>
</tr>
</tbody>
</table>

Find the conditional distribution of x (for given y). Are x and y independent random variables?

(b) Suppose that the joint pdf of continuous random variable (x, y) is given by

\[ f(x, y) = e^{-y}, \quad \text{for } x > 0, y > x \]
\[ = 0, \quad \text{elsewhere.} \]

(i) Find the marginal pdf of x and y.
(ii) Evaluate \( P(x > 2 | y < 4) \).

2. (a) Let x and y represent the life lengths of two light bulbs manufactured by different processes. Assume that x and y are independent random variables with pdf’s f and g, respectively, where

\[ f(x) = e^{-x}, \quad x \geq 0 \]
\[ = 0, \quad \text{elsewhere} \]

\[ g(y) = 2e^{-2y}, \quad y \geq 0 \]
\[ = 0, \quad \text{elsewhere.} \]

Find the pdf of the random variable \( Z = \frac{x}{y} \).

(b) Fit a least squares curve of the form \( y = a_0 + a_2x^2 \) for the following data:

<table>
<thead>
<tr>
<th>x</th>
<th>1</th>
<th>2.5</th>
<th>3.5</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>3.8</td>
<td>15</td>
<td>26</td>
<td>33</td>
</tr>
</tbody>
</table>

Contd……..2
3. (a) Assuming that the population from which the following sample (copper content [\%] of brass) 65, 65, 64, 63, 65, 66, 63, 64, 62, 63 is taken normally, determine a 99% confidence interval for the mean \( \mu \) of population.

(b) Producer of ‘Gutkha’ claims that the nicotine content in his ‘Gutkha’ on the average is 1.83 mg. A random sample of 8 ‘Gutkha’ of this type have the nicotine contents of 2.0, 1.7, 2.1, 1.9, 2.2, 2.1, 2.0, 1.6 mg Test the null hypothesis \( \mu = 1.83 \) against the alternative hypothesis \( \mu > 1.83 \). Use 0.05 level of significance.

SECTION – B

4. (a) Define basis of a vector space. Show that the set \{\( (1,0,0), (1,1,0), (1,1,1), (0,1,0) \)\} spans the vector space \( \mathbb{R}^3 \) but is not a basis set.

(b) Let \( V \) be the set of all real functions \( y = y(x) \) satisfying D.E. \[ 6+6 \]

\[
\frac{d^3y}{dx^3} + 6\frac{d^2y}{dx^2} + 11\frac{dy}{dx} + 6y = 0.
\]

Prove that \( V \) is a 3-dimensional vector space.

Define inner product on \( V \) by \( <u,v> = \int_{0}^{\infty} uv \ dx \), find an orthogonal normal basis set for \( V \).

5. (a) If the matrix of a linear transformation \( T \) on \( V_3(\mathbb{R}) \) relative to standard basis of \( V_3(\mathbb{R}) \) is

\[
\begin{bmatrix}
0 & 1 & 1 \\
1 & 0 & -1 \\
-1 & -1 & 0
\end{bmatrix}
\]

Find the matrix of \( T \) relative to the basis \( B = \{(0, 1, -1), (1, -1, 1), (-1, 1, 0)\} \).

(b) Compute the singular value (SV) decomposition of the matrix \( A = \begin{bmatrix} 1 & 2 \\ 1 & 1 \\ 1 & 3 \end{bmatrix} \).

6. (a) Evaluate \( J_{\frac{1}{2}}(x) \) and \( J_{-\frac{1}{2}}(x) \), and hence evaluate \( \left[J_{\frac{1}{2}}(x)\right]^2 + \left[J_{-\frac{1}{2}}(x)\right]^2 \).

(b) Prove that

\[
\frac{d}{dx}(xJ_n J_{n+1}) = x[J_n^2(x) - J_{n+1}^2(x)].
\]

7. (a) Prove that

\[
\left[1 - 2xt + t^2\right]^{\frac{1}{2}} = \sum_{n=0}^{\infty} P_n(x) t^n, \quad |t| < 1 \text{ and hence evaluate } P_{2n}(0) \text{ and } P_{2n+1}(0), \text{ where } P_n(x) \text{ is Legendre's polynomials of I kind.}
\]

(b) Show that

(i) \( (1-x^2)T'_n(x) = \frac{n}{2} [T_{n-1}(x) - T_{n+1}(x)] \).

(ii) \[ \int T_n(x) \ dx = \frac{1}{2} \left[ \frac{1}{n+1} T_{n+1}(x) - \frac{1}{n-1} T_{n-1}(x) \right] \quad (n \geq 2). \]

****
Table A9
$t$-Distribution

Values of $z$ for given values of the distribution function $F(z)$ (see p. 1112).
Example: For 9 degrees of freedom, $z = 1.83$ when $F(z) = 0.95$.

<table>
<thead>
<tr>
<th>$F(z)$</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
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<tbody>
<tr>
<td>0.5</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>0.6</td>
<td>0.32</td>
<td>0.29</td>
<td>0.28</td>
<td>0.27</td>
<td>0.27</td>
<td>0.26</td>
<td>0.26</td>
<td>0.26</td>
<td>0.26</td>
<td>0.26</td>
</tr>
<tr>
<td>0.7</td>
<td>0.73</td>
<td>0.62</td>
<td>0.58</td>
<td>0.57</td>
<td>0.56</td>
<td>0.55</td>
<td>0.55</td>
<td>0.55</td>
<td>0.54</td>
<td>0.54</td>
</tr>
<tr>
<td>0.8</td>
<td>1.28</td>
<td>1.06</td>
<td>0.98</td>
<td>0.94</td>
<td>0.92</td>
<td>0.91</td>
<td>0.90</td>
<td>0.89</td>
<td>0.88</td>
<td>0.88</td>
</tr>
<tr>
<td>0.9</td>
<td>3.08</td>
<td>1.89</td>
<td>1.64</td>
<td>1.53</td>
<td>1.48</td>
<td>1.44</td>
<td>1.41</td>
<td>1.40</td>
<td>1.38</td>
<td>1.37</td>
</tr>
<tr>
<td>0.95</td>
<td>6.31</td>
<td>2.92</td>
<td>2.35</td>
<td>2.13</td>
<td>2.02</td>
<td>1.94</td>
<td>1.89</td>
<td>1.86</td>
<td>1.83</td>
<td>1.81</td>
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<tr>
<td>0.975</td>
<td>12.7</td>
<td>4.30</td>
<td>3.18</td>
<td>2.78</td>
<td>2.57</td>
<td>2.45</td>
<td>2.36</td>
<td>2.31</td>
<td>2.26</td>
<td>2.23</td>
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<tr>
<td>0.99</td>
<td>31.8</td>
<td>6.96</td>
<td>4.54</td>
<td>3.75</td>
<td>3.36</td>
<td>3.14</td>
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<tr>
<td>0.995</td>
<td>63.7</td>
<td>9.92</td>
<td>5.84</td>
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<td>0.999</td>
<td>318.3</td>
<td>22.3</td>
<td>10.2</td>
<td>7.17</td>
<td>5.89</td>
<td>5.21</td>
<td>4.79</td>
<td>4.50</td>
<td>4.30</td>
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</table>

4. $t_a$-Critical Values of the $t$-Distribution

<table>
<thead>
<tr>
<th>$\nu$</th>
<th>0.40</th>
<th>0.30</th>
<th>0.20</th>
<th>0.15</th>
<th>0.10</th>
<th>0.05</th>
<th>0.025</th>
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<tbody>
<tr>
<td>1</td>
<td>0.325</td>
<td>0.727</td>
<td>1.376</td>
<td>1.963</td>
<td>3.078</td>
<td>6.314</td>
<td>12.706</td>
</tr>
<tr>
<td>2</td>
<td>0.289</td>
<td>0.617</td>
<td>1.061</td>
<td>1.386</td>
<td>1.886</td>
<td>2.920</td>
<td>4.303</td>
</tr>
<tr>
<td>3</td>
<td>0.277</td>
<td>0.584</td>
<td>0.978</td>
<td>1.250</td>
<td>1.638</td>
<td>2.353</td>
<td>3.192</td>
</tr>
<tr>
<td>4</td>
<td>0.271</td>
<td>0.569</td>
<td>0.941</td>
<td>1.190</td>
<td>1.533</td>
<td>2.132</td>
<td>2.776</td>
</tr>
<tr>
<td>5</td>
<td>0.267</td>
<td>0.559</td>
<td>0.920</td>
<td>1.156</td>
<td>1.476</td>
<td>2.015</td>
<td>2.571</td>
</tr>
<tr>
<td>6</td>
<td>0.265</td>
<td>0.553</td>
<td>0.906</td>
<td>1.134</td>
<td>1.440</td>
<td>1.943</td>
<td>2.447</td>
</tr>
<tr>
<td>7</td>
<td>0.263</td>
<td>0.549</td>
<td>0.896</td>
<td>1.119</td>
<td>1.415</td>
<td>1.895</td>
<td>2.365</td>
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<tr>
<td>8</td>
<td>0.262</td>
<td>0.546</td>
<td>0.889</td>
<td>1.108</td>
<td>1.397</td>
<td>1.860</td>
<td>2.306</td>
</tr>
<tr>
<td>9</td>
<td>0.261</td>
<td>0.543</td>
<td>0.883</td>
<td>1.100</td>
<td>1.383</td>
<td>1.833</td>
<td>2.262</td>
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<tr>
<td>10</td>
<td>0.260</td>
<td>0.542</td>
<td>0.879</td>
<td>1.093</td>
<td>1.372</td>
<td>1.812</td>
<td>2.228</td>
</tr>
<tr>
<td>11</td>
<td>0.260</td>
<td>0.540</td>
<td>0.876</td>
<td>1.088</td>
<td>1.363</td>
<td>1.796</td>
<td>2.201</td>
</tr>
<tr>
<td>12</td>
<td>0.259</td>
<td>0.539</td>
<td>0.873</td>
<td>1.083</td>
<td>1.356</td>
<td>1.782</td>
<td>2.179</td>
</tr>
<tr>
<td>13</td>
<td>0.259</td>
<td>0.537</td>
<td>0.870</td>
<td>1.079</td>
<td>1.350</td>
<td>1.771</td>
<td>2.160</td>
</tr>
<tr>
<td>14</td>
<td>0.258</td>
<td>0.537</td>
<td>0.868</td>
<td>1.076</td>
<td>1.345</td>
<td>1.761</td>
<td>2.145</td>
</tr>
<tr>
<td>15</td>
<td>0.258</td>
<td>0.536</td>
<td>0.866</td>
<td>1.074</td>
<td>1.341</td>
<td>1.753</td>
<td>2.131</td>
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</table>
Answer all the questions. Assume suitable data if missing. Notations and symbols used have their usual meaning.

### Q.No. | Question | M.M.
---|---|---

**Attempt ANY FIVE from the seven questions below.**

1(a) Explain the operation of a Time-to-Digital Converter used in a Digital Phase-Locked Loop (DPLL). [06]

1(b) What are the limitations of a Charge-Pump PLL? How could these shortcomings be addressed? [06]

2(a) Design a Digitally Controlled Programmable Gain Amplifier (PGA) capable of providing gain tunable from 1 to 100. [06]

2(b) Explain the working of a Frequency-to-Voltage converter circuit. [06]

3(a) Design a Four Quadrant Voltage Multiplier circuit using Operational Amplifiers. [06]

3(b) Design a circuit for Triangular–to–Sinusoidal waveform conversion. [06]

4(a) Consider a biomedical signal acquisition setup. What is the need of Isolation Amplifiers? [06]

4(b) Design a circuit to provide an output signal frequency equal to \( n \cdot f_{\text{ref}} \) where \( f_{\text{ref}} \) is the input signal frequency, and \( 1 \leq n \leq 10 \). [06]

Contd.....2.
5(a) Design a 3-bit digitally controlled quadrature oscillator for frequency of oscillation equal to 100 MHz.

5(b) A voltage controlled oscillator is to be designed for some application. The required tunable range of frequencies is from 88 MHz to 108 MHz. Design the oscillator and calculate the minimum and maximum values of control voltage for the circuit.

6(a) With suitable circuit diagrams, describe the working of a Four-Quadrant Transconductance Multiplier.

6(b) Design a function generator circuit capable of providing sinusoidal, triangular, square, and pulse waveforms.

7(a) With the help of small-signal equivalent circuit, explain how Cascoding can be employed to extend the bandwidth of an amplifier.

7(b) Design an active-loaded CMOS differential amplifier with DC gain of 10 and differential input resistance equal to 1 KΩ.
M.TECH. (AUTUMN SEMESTER) EXAMINATION
ELECTRONICS ENGINEERING
(Electronic Circuits & System Design)
ADVANCE DEVICE MODELLING
EL-613

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Explain the meaning of the following terms used in short channel MOS devices: Channel- Length Modulation (CLM) (i) Drain Induced Barrier Lowering (DIBL) (ii) Substrate Current-Induced Body Effect (SCBE)</td>
<td>[10]</td>
</tr>
<tr>
<td>1(b)</td>
<td>Carry out y-parameter analysis of the model shown in Fig. 1 to show that $R_{SUB} = \frac{Re{Y_{SUB}}}{[Im{Y_{SUB}}]^2}$, where $R_{SUB} = \frac{R_{DB}(R_{SB} + R_{DSB})}{R_{DB} + R_{SB} + R_{DSB}}$</td>
<td>[05]</td>
</tr>
</tbody>
</table>

[Diagram of the model shown as Fig. 1]

| 2(a)  | Differentiate between the power match and the noise match. Explain why it is not possible to achieve both type of match simultaneously in radio frequency circuits. | [05] |
| 2(b)  | For MOS capacitor with an n-type semiconductor substrate doped at $8 \times 10^{15}$ cm$^{-3}$, and an oxide thickness of 200 nm. Assume there is no oxide or interface charge. Make a sketch of energy band diagram for the n-substrate MOS capacitor described above for (i) no applied bias, (ii) accumulation, and (iii) threshold | [05] |

Contd.....2.
2(c) What is transit-time frequency, $f_T$ of a transistor? Calculate $f_T$ for the transistor model shown in Fig. 2. Briefly discuss what effect does $R_b$ has on $f_T$ and how it affects the transistor noise performance.

![Fig. 2](image)

2'(a) How rf model differ from analog model? Enumerate various steps involved in rf model development.

2'(b) Show that threshold voltage $V_T$ of MOS structure with p-type substrate can be expressed as:

$$V_T = V_{FB} + 2\Phi_b + \frac{\sqrt{4\varepsilon_s q N_s \Phi_b}}{c_i}$$

Where $V_{FB}$ is flat band voltage and $c_i$ is oxide capacitance per unit area.

2'(c) What is gate tunnelling leakage current? Illustrates it dependence on the gate voltage by taking for 04 different CMOS technologies (e.g. 45nm, 65nm, 90nm & 130nm).

3(a) What is body effect? How does it influence the threshold voltage of a MOS transistor?

3(b) Differentiate between unity gain frequency $f_T$ and maximum frequency of oscillation $f_{MAX}$. Show that for deep sub-micron MOSFET operating under high field region $f_T$ can be expressed as: $f_T = V_{SAT}/(2\pi L)$, Where $V_{SAT}$ is saturation velocity and $L$ is the gate length of MOSFET.

3(c) What are various types of BSIM models? State the advantages of BSIM-CMG over BSIM4 model.
### 3'(a) Write short-notes on the following:

i) MOS structure  

ii) Charge control model  

### 3'(b) State the physical origin of $R_{GD}$ used in the model (See Fig. 3). Carry out small-signal analysis of the model to show that

$$R_{GD} = -\frac{\text{Re}(Y_{12})}{\omega^2 C_{GD}^2}$$

![Fig. 3](image)

### 4(a) What do you mean by noise figure? By using relevant theory explain how the effects of various noises are modelled in BSIM3.

### 4(b) Carry out y-parameters analysis of the circuit shown in Fig. 4 to show that

$$C_m = \frac{\text{Im}(Y_{21})}{\omega} - g_m R_G (C_{GS} + C_{GD}) - C_{GD}$$

![Fig. 4](image)

### 4(c) What do you mean by "DIBL Effect"? Explain how it affects the threshold voltage of MOS device.
2015-16
M. TECH. (I SEMESTER) EXAMINATION (AUTUMN)
ELECTRONICS ENGINEERING
VLSI DESIGN
EL-621

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer any five questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.
1(a) Consider a pseudo-NMOS inverter fabricated in 0.25 um CMOS technology for
which \( \mu_nC_ox = 115 \, \mu A/V^2 \), \( \mu pC_ox = 30 \, \mu A/V^2 \), \( V_{in} = -V_{lp} = 0.5 \, V \) and \( V_{DD} = 2.5 \, V \).
Let the \((W/L)\) ratio of \( Q_n \) be \((0.375 \, \text{ um} / 0.25 \, \text{um})\) and \( r = 9 \). Find
1. Noise Margins for high \((NM_H)\) and low level inputs \((NM_L)\)
2. \( I_{stat}\) and \( P_D\)
3. Propagation delay \((t_p)\), assuming a total capacitance at the inverter output of
   7 Ff.
1(b) Design a CMOS full adder circuit with inputs \( A, B, C \) and two outputs \( S \) and \( C_o \)
such that \( S \) is 1 if one or three inputs are 1 and \( C_o \) is 1 if two or more inputs are 1.

2(a) With the help of transistor level implementation, explain the operation of 2 input
NAND gate in BiCMOS technology. Also discuss the advantages and applications
of BiCMOS circuits.

2(b) For a pseudo NMOS inverter what value of ‘r’ results in \( NM_L = NM_H \). Let \( V_{DD} = 5V \) and \( |V_r| = 0.8V \). What is the resulting noise margin.

3(a) With the help of Gajski-Kuhn Y-chart, explain the various description domains and
abstraction levels for an integrated circuit.

3(b) Discuss the structured design techniques for the successful implementation of
integrated circuit design.

4(a) Write short technical notes on the following VLSI design methodologies:
   (i) Gate Array Design
   (ii) Standard Cell Design
   (iii) Programmable Array Logic

contd... 2
5(a) Discuss in detail the concept of 'Floorplanning'. Also highlight the difference between slicing and non-slicing floorplanning with necessary diagrams.

5(b) Discuss in detail the Built-in Self Test (BIST). Explain it with necessary circuit diagrams.

6(a) Give the internal details of the routing cell and explain how signals are routed in an ACTEL FPGA. Also discuss the significance of 'Personalised RAM'.

6(b) Draw the internal diagram of an ACTEL FPGA logic cell and explain its working by configuring the built-in 16*1 RAM for obtaining the logic function SUM(A,B,C,D) where A, B, C and D are the inputs to the logic cell.

7 Using suitable block diagrams, explain the operation of Configurable Logic Block (CLB) and Input Output Block (IOB) used in XILINX Spartan series FPGA.
2015-16
I SEMESTER (AUTUMN) M.TECH. EXAMINATION
ELECTRONICS ENGINEERING
IC PROCESSES AND FABRICATION
EL-623

Max. Marks: 60
1. Attempt ANY FIVE Questions
2. Make appropriate assumptions if required
3. Symbols and abbreviations have their usual meanings.

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<thead>
<tr>
<th>Q.No.</th>
<th>Questions</th>
<th>MM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>What is the need of ultra clean environment for the fabrication of Integrated Circuits? Describe the class- 1 cleanliness. What are the Do’s and Don’ts for the clean room. What are the sources of contaminations?</td>
<td>06</td>
</tr>
<tr>
<td>1(b)</td>
<td>What are the physical mechanisms responsible for the removal of airborne particles from clean room?</td>
<td>06</td>
</tr>
<tr>
<td>2(a)</td>
<td>What are the common design practices for clean rooms?</td>
<td>06</td>
</tr>
<tr>
<td>2(b)</td>
<td>Describe the steps used in the preparation of Si – wafers.</td>
<td>06</td>
</tr>
<tr>
<td>3(a)</td>
<td>What is wet cleaning? What are the advantages of wet cleaning? What is the need of supercritical fluid cleaning?</td>
<td>06</td>
</tr>
<tr>
<td>3(b)</td>
<td>Describe the process of dry wafer cleaning.</td>
<td>06</td>
</tr>
<tr>
<td>4(a)</td>
<td>Briefly describe the advantages and disadvantages of Physical Vapour Deposition (PVD). How PVD is different from Chemical Vapour Deposition (CVD)? With sketches, explain the operation of Vacuum Evaporation System. How alloys are deposited using Vacuum Evaporation System.</td>
<td>06</td>
</tr>
</tbody>
</table>
| 4(b)  | Assume that the gas AB is introduced into a reactor and that the only chemical reaction that occurs in the chamber is  

\[
AB \ (g) \leftrightarrow A \ (g) + B \ (g)
\]

If the process is run at 1 atm (760 torr) and temperature of 1000 K the process reaches chemical equilibrium, calculate the partial pressure of each species. The equilibrium constant for the reaction is given by  

\[
K_p (T) = 1.8 \times 10^9 (\text{torr}) e^{-2.0eV / kT}.
\]

Contd....2.
<p>| | |</p>
<table>
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<th></th>
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</thead>
<tbody>
<tr>
<td><strong>5(a)</strong></td>
<td>What is the need of epitaxial layer and how it is deposited?</td>
</tr>
<tr>
<td><strong>5(b)</strong></td>
<td>With sketches, explain the operation of Sputtering System.</td>
</tr>
<tr>
<td><strong>5(c)</strong></td>
<td>Why low temperature processes are preferred in IC fabrication? With the help of sketch, explain the operation of a typical LPCVD system.</td>
</tr>
<tr>
<td><strong>6(a)</strong></td>
<td>What are the applications of silicon dioxide. With the help of sketch, explain the growth of silicon dioxide. A 100 A gate oxide is required for some technology. It has been decided that the oxidation will be carried out at 1000 °C, in wet ambient. If there is no initial oxide, for how long should the oxidation be done? Is the oxidation in the linear regime, the parabolic regime or between the two? (A = 0.226, B = 0.287, ( \tau = 0.37 ) hr).</td>
</tr>
<tr>
<td><strong>6(b)</strong></td>
<td>Describe the photolithography process step by step with the help of sketches. What is the difference between isotropic and anisotropic etching?</td>
</tr>
</tbody>
</table>
| **7(a)** | How a bipolar transistor fabrication process is carried out. Hence explain:  
   a) the role of the \( n^+ \) buried layer  
   b) why the emitter, base and collector diffusions are carried out in a specific order?  
   c) how the gain of the BJT could be increased? | 06 |
| **7(b)** | With the help of sketches, explain the all fabrication steps of BiCMOS technology. | 06 |
1 (a) Give an estimate of the number of binary sequences of length 10000 with 3000 zeros and 7000 ones.
(b) An information source can be modeled as a bandlimited process with a bandwidth of 6000 Hz. This process is sampled at a rate higher than the Nyquist rate to provide a guard band of 2000 Hz. It is observed that the resulting samples take values in the set \{-4, -3, -1, 2, 4, 7\} with probabilities 0.2, 0.1, 0.15, 0.3, 0.2 respectively. What is the entropy of the discrete time source in bits/sec?
(c) What is the difference between a flat fading channel and a frequency selective channel? Derive an expression for the channel capacity of a frequency selective fading channel.

2 (a) Show that among all continuous random variables (RV) with given variance and mean the Gaussian RV has the highest differential entropy.
(b) Each sample of a Gaussian memoryless source has a variance equal to 4 and the source produces 8000 samples/sec. The source output is to be transmitted via an additive white Gaussian noise channel with the bandwidth equal to 4000 Hz. It is desirable to have a distortion per sample (assume squared-error distortion) not exceeding 1 at the destination. What is the minimum required signal-to-noise ratio of the channel?
(c) A rat runs through the maze shown in Fig - 1. At each step it leaves the room it is in by choosing at random one of the doors out of the room.

![Maze Diagram](image-url)
(i) Find the state transition matrix of this Markov chain.
(ii) Find the stationary distribution of the states

3 (a) Obtain the binary coded string for the following tongue twister using any source coding technique (assume space also is a symbol).
    
peter piper picked a peck of pickled peppers

(b) Let a message consists of 4 bits. The LT encoder generates 6 coded bits $c_i$, $i=0,...,5$. The degree distribution of the coded bits are $\{2, 1, 2, 3, 4, 3\}$ respectively.

   (i) Suggest a scheme of generating coded bits.
   (ii) Is it the only possible way of generating a coded sequence with this degree distribution? Explain.
   (iii) If you receive $c_i$, $i=1,...,5$ only, can you still recover the message? How?

4 (a) What are the blocklength, dimensions, and burst correction performance of a binary Fire code with generator polynomial $g(x) = (x^{15} - 1)(x^8 + x^4 + x^3 + x^2 + 1)$?

(b) The convolutional code described by the generator polynomial matrix $G(x) = [x^1 + x + x^2]$, is used with polar signaling, i.e., $0 \rightarrow -1, 1 \rightarrow +1$. Determine the most likely information sequence if the received output of the matched filter is $r = [-1, -1, 1.5, 2, 0.7, -0.5, -0.8, -3, 3, 0.2, 0.1]$.

5 (a) Let $C$ be the binary maximal length separable (simplex) $(7, 3, 4)$ code. Determine the check matrix of the extended code $(8, 3, d)$ obtained from $C$. Determine the value of $d$.

(b) Let $\alpha$ be a primitive element of the field $GF(2^4)$. Show that $\{0, 1, \alpha^5, \alpha^{10}\}$ is a field.

(c) Suppose that a Turbo code is generated by the generator matrix of the form $G = [I \; [g(x)] \; \Pi[g(x)]]$ with the trellis stage is shown in Fig – 2. Let the permutation matrix $\Pi$, has nonzero elements at the following locations: 9, 4, 8, 7, 10, 1, 3, 6, 2, 5 in row 1, row2……, respectively. Encode the message $[1 \; 1 \; 0 \; 0 \; 1 \; 0 \; 1 \; 0 \; 1 \; 1]$ using this encoding scheme.

Contd…..3.
6 (a) What is a standard array? Construct a standard array of the block code described by the following check matrix
\[
H = \begin{bmatrix}
1 & 0 & 1 & 0 & 0 \\
1 & 1 & 0 & 1 & 0 \\
0 & 1 & 0 & 0 & 1
\end{bmatrix}.
\]
(b) State the Ungerboeck's TCM design rules. Why do you apply these rules in trellis coded modulation?
(c) The parity check matrix of a (12, 3) LDPC code is given by
\[
H = \begin{bmatrix}
0 & 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \\
1 & 1 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 0 & 0 \\
1 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 1 & 0 & 0 & 0 \\
1 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 1 & 0 & 1 \\
0 & 0 & 0 & 0 & 1 & 0 & 1 & 0 & 0 & 1 & 1 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 & 0 & 0
\end{bmatrix}.
\]
Sketch the Tanner graph for this code. Is there any cycle in the graph?
2015-16
M.TECH. (AUTUMN SEMESTER) EXAMINATION
ELECTRONICS ENGINEERING
(Communication & Information Systems)
IMAGE AND VIDEO PROCESSING
EL-663

Maximum Marks: 60

Credits: 04

Duration: Three Hours

Answer any four questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question

1(a) Explain the significance of rods and cones in human visual system. [03]

1(b) List medical, industrial and remote sensing (at least two of each) applications of digital image/video processing. [03]

1(c) A 3×3 image shown in Fig. 1(a) is filtered using symmetrical 2-D filter shown in Fig. 1(b). Find the output image by performing 2D convolution. What is the nature of this filter? [05]

1(d) A 4×4 pixel image \( x(n_1, n_2) \) is shown in Fig. 2. If \( X(k_1, k_2) \) be the 4×4 DFT of \( x(n_1, n_2) \), find the value of \( X(0, 0) \). [04]

Contd.....2.
2(a) Consider a two dimensional filter \( h(n_1, n_2) \)

\[
h(n_1, n_2) = \begin{bmatrix} -1 & -1 & -1 \\ -1 & 9 & -1 \\ -1 & -1 & -1 \end{bmatrix}.
\]

Obtain the filter transfer function, \( H(u, v) \) for performing the equivalent process in frequency domain. By finding \( H(0, 0) \), verify whether it is low pass or high pass filter.

2(b) Differentiate between histogram equalization and histogram specification methods. Write the algorithm of histogram equalization method of contrast enhancement.

2(c) A certain imaging system can be modelled as \( g(x, y) = \log([f(x, y) + n(x, y)]) \), where \( f(x, y) \) is the signal of interest, \( g(x, y) \) is the observed image data and \( n(x, y) \) is the noise. As is typical, the noise component is dominant in the high frequency spectrum and the signal of interest is mostly of low frequency components. Suggest a suitable method to enhance the quality of the observed signal while de-emphasizing noise. Explain your answer.

3(a) What is the chromaticity diagram? Explain its significance in colour mixing. Describe the properties of chromaticity diagram.

3(b) You are asked to produce two images, one with a checker board pattern of values 0 and 255, and a second with a constant value of \( (r, g, b) = (a, a, a) \), where ‘a’ may have any value between 0 to 255. The value of ‘a’ is then adjusted so that the two images match when viewed from a distance. What is the value of gamma for the display in terms of value of ‘a’? Use normalized color intensities.

3(c) An image described by the function \( f(x, y) = 2\cos(2\pi(3x + 4y)) \) is sampled such that \( \Delta x = \Delta y = 0.2 \). The reconstruction filter is an ideal low-pass filter with bandwidth \( \left( \frac{1}{2}\Delta x, \frac{1}{2}\Delta y \right) \). Find the image reconstructed from its samples.

4(a) Suppose your smart phone has a 10-megapixel camera. Without any form of compression, how big would a 24bit RGB colour image be?

4(b) For the \( 2 \times 2 \) transform \( A \) and image \( U \) given below, calculate the transformed image

Contd.....3.
V and the basis images. Also show that the reconstructed image from the transformed coefficients is equal to the original image.

\[ A = \frac{1}{2} \begin{bmatrix} \sqrt{3} & 1 \\ -1 & \sqrt{3} \end{bmatrix}, \quad U = \begin{bmatrix} 2 & 3 \\ 1 & 2 \end{bmatrix} \]

4(c) Compare the properties of Haar, slant, KLT, and DCT transforms. [04]

4(d) Explain the significance of zig-zag scanning in JPEG image coder. [03]

5(a) Discrete wavelet transform can be considered as a special case of sub-band coding as well as a modified form of Short-time Fourier transform (STFT). Justify the statement with valid arguments. [05]

5(b) How scalability feature is implemented in JPEG2000. Explain how bits of code-blocks should be organised to achieve spatial as well as rate scalability. [05]

5(c) What is motion compensation? Why it is used in video coding system? Describe full search block-based motion estimation algorithm. [05]

6(a) Draw the block diagram of typical hybrid video encoder and decoder, used in most of the standard video coders. [04]

6(b) Why MPEG-2 is still the most commercially used video coder? Explain. [03]

6(c) What do you mean by I-, P-, and B- frames in context of video coding? What is the use of these frames in video coding? [04]

6(d) List some of the new features that were included in H.264/AVC video coding standards. Explain the reason of including these features. [04]
2015-2016  
M. Tech (Ist SEMESTER) EXAMINATION (AUTUMN)  
(ELECTRONICS ENGG C& IS)  
Course No. EL-672  
Special Purpose RADAR  
Credits - 04

Maximum Marks: 60  
Duration: Three Hours

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

| Q1 | (a) What are radar beacons? What applications do they have? (5 marks)  
(b) The BW of a pulse compression radar is 100MHz. Its pulse width before compression is 4 micro-second. Find the compressed pulse width and compression ratio. | 7 |
| Q2 | (a) Discuss the effect of earth on the propagation of radar waves  
(b) Calculate the range to horizon and also the corresponding depression angle of a radar at 10,000 and 20000 ft of altitude. | 7 |
| Q3 | (a) A pulsed radar is transmitting 1 microsecond pulses at a repetition rate of 1 kHz. Assuming no pulse compression technique has been used, determine whether two target separated in range by 500m but having same angular position can be resolved by this radar on the basis of range.  
(b) What is the principle of OTH (over the horizon radar)? What are its applications and limitations? | 7 |
| Q4 | With the help of block diagram explain the principle and working of airborne weather radar system?  
OR  
Q4' | Explain the various methods of radar jamming. | 12 |
| Q5 | Explain in details the salient features of Global Positioning System.  
OR  
Q5' | What are the basic elements of MLS system? What are the advantages of MLS over ILS. | 12 |
INSTRUCTIONS TO THE EXAMINEES

- Answer any FOUR questions.
- Assume suitable data if missing.
- Notations used have their usual meaning.

Q.No.

1 (a) A telephone modem is used to connect a personal computer to a host computer. The speed of the modem is 56 kbps and the one-way propagation delay is 100 ms. Find the efficiency for Stop-and-Wait ARQ if the frame size is 256 byte. Assume a bit error rate of $10^{-4}$, zero processing delay, 64 bit acknowledgement and 64 bits for header and CRC.

1 (b) Suppose a large message having $10^6$ bits is to be transmitted over two hops. If the transmission line in each hop has an error rate of $p=10^{-6}$ and that each hop does error checking and retransmission. How many bits will be transmitted for a successful reception using message switching?

2 (a) What is collision domain? Explain with the help of an example how it can be reduces in a computer network.

2 (b) Calculate the ring latency in terms of bits for a link speed of 4Mbps having 20 stations with an average inter-station separation of 100m. Assume the processing delay of 2.5 bits at each station.

2 (c) Explain how collision avoidance is achieved in a wireless communication network.

3 (a) A sub-network uses the Shortest Path Dijkstra’s algorithm for routing packets in the network. Write down a pseudo-code for this sub-network having N nodes.

Contd…..2.
For a mesh network with \( N \) nodes, find the minimum and maximum cost function for a packet to be transferred from a node \( i \) to node \( j \). Assume that all the link have same cost function \( C \) associated to it.

3 (b) Given the address 132.6.17.85, find the network class, network address, netid and hostid. Find also the maximum number of hosts that can be connected to this network.

4 (a) Calculate the expression of length of the queue in M/M/1 queuing system based on the Birth Death Process. State clearly the assumptions made for this calculation.

4 (b) With reference to the Queuing Theory differentiate between Reneging and Jockeying.

4 (c) A 32 bit sequence number field is used in the TCP header, if the bit rate of the link is 1Gbps find the wraparound time of the sequence number.

5 (a) Explain how the congestion window is used to avoid congestion in a computer network.

5 (b) Differentiate between 'Masquerade' and 'Denial of Service' Attack on a computer communication network.

5 (c) What are the different types of attack a cryptanalyst can perform encrypted message?

6 (a) Draw the block diagram of AES encryption round and explain the working of AES scheme.

6 (b) Explain with reference to IPv6 how Daisy chain is used for extension of headers.