2014 – 2015
M.TECH. (AUTUM SEMESTER) EXAMINATION
(COMPUTER ENGINEERING)
NUMERICAL & STATISTICAL TECHNIQUES
(AM – 661)

Maximum Marks: 60
Duration: Three Hours

Note: Answer FIVE questions by selecting at least TWO questions from each Section.
The normal distribution table is provided with the question paper.

SECTION – A

1. (a) Approximate \( y \) by a function of the form \( a\sqrt{x} + be^x \) for the data (in least square sense):

<table>
<thead>
<tr>
<th>x</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>y</td>
<td>1</td>
<td>-0.7183</td>
<td>-4.5606</td>
<td>-16.6214</td>
</tr>
</tbody>
</table>

(b) Approximate \( \frac{1}{1 + x^2} \) by \( a + bx + cx^2 \) in least square sense in \([-1, 1]\). [6+6]

2. (a) Given

\[
\frac{dy}{dx} = xyz, \quad y(1) = \frac{1}{3}
\]
\[
\frac{dz}{dx} = \frac{xy}{z}, \quad z(1) = 1
\]

Obtain \( y(1.2) \) and \( z(1.2) \) by applying three iterations of modified Euler’s method
(choose \( h = 0.2 \)).

(b) \( \frac{d^2y}{dx^2} + 2y = 0, \quad y(0) = 2, \quad y'(0) = -2 \), find the value of \( y(0.2) \) by applying Runge-Kutta method of order 4 (choose \( h = 0.2 \)). [6+6]

3. (a) Consider \( \frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2} = \sin(x + y) \),

\[ 0 \leq x \leq 1, \quad 0 \leq y \leq 1, \]

\( U(x, y) = \cos(x + y) \) on the boundary. Solve it by applying two iterations of
Liemam’s method with \( h = \frac{1}{3} \). (Also take \( k = h \)).

(b) Use Cranh – Nicolson scheme to solve

\[
\frac{\partial u}{\partial t} = 2 \frac{\partial^2 u}{\partial x^2}, \quad 0 \leq t \leq 1.5, \quad 0 \leq x \leq 4
\]

Given the initial condition:

\( u(x, 0) = 50(4 - x), \quad 0 \leq x \leq 4 \) (Take \( h = 1 \)) and the boundary condition:

\( u(0, t) = 0, \quad 0 \leq t \leq 1.5 \)
\( u(4, t) = 0, \quad 0 \leq t \leq 1.5 \)

Solve upto two time levels.

Contd…..2
4. (a) Solve the vibrating string problem
\[
\frac{\partial^2 u}{\partial t^2} + \frac{\partial^2 u}{\partial x^2}, \quad 0 \leq x \leq 1
\]
with \( k = h = 0.2 \) with initial conditions \( 4(x, 0) = x (1 - x), \frac{\partial u}{\partial t}(x,0) = 0 \)
and boundary conditions \( u(0, t) = u(1, t) = 0, \) upto two time levels.
\[ [6+6] \]
(b) Apply to find an approximate solution of the integral equation
\[
y(t) = t \ e^t - 2e^t \int_0^t e^{-s} y(s) \, ds, \quad y(0) = 0.
\]

SECTION – B

5. Suppose that the two-dimensional random variable \((X, Y)\) is uniformly distributed over the triangular region \( x = 0, y = 0, x + y = 1. \)
(a) Find the probability distribution function \( f(x, y) \) of \((x, y)\), the marginal probability distribution functions \( g(x) \) and \( h(y) \) of random variables \( X \) and \( Y \) respectively.
(b) Find \( E(X), E(Y), V(X) \) and \( V(Y) \)
(c) Find \( E(XY) \) and the correlation coefficient? \[ 4+4+4 \]

6. (a) Two refills for a ball-point pen are selected at random from a box that contains 4 blue refills, 3 red refills and 3 black refills. Let \( X \) be the number of red refills and \( Y \) be the number of black refills selected. Calculate
(i) the joint probability distribution table for the bivariate random variable \((x, y)\).
(ii) the marginal probabilities.
(iii) \( P(X = 0 \mid Y = 1), \quad P((X, Y) \mid X + Y < 2). \)
(b) Suppose \( X \) and \( Y \) are independent random variables with the following probability distribution function:
\[
X : g(x) = \frac{8}{3x^3}, \quad 1 < x < 2
\]
\[
Y : h(y) = \frac{2}{3y}, \quad 1 < y < 2
\]
Find the probability distribution function of \( Z = XY. \) \[ 6+6 \]

7. (a) An electronic device has a life length \( T \) which is exponentially distributed with parameter \( \alpha = 0.001. \) Suppose that 100 such devices are tested.
(i) Calculate \( P(900 < T < 1050) \)
(ii) What is the probability that the largest observed value exceeds 7000 hrs?
(iii) What is the probability that the shortest time to failure is less than 500 hrs?

Contd......3
(b) Let $X$ be a normal random variable with variance $\sigma^2 = 12$. Using a sample of size $n = 15$ with mean $\bar{X}$, test the null hypothesis $H_0: \mu = \mu_0 = 25$ against the alternative hypothesis $H_1: \mu \neq 25$. Choose significant level $\alpha = 4\%$.

8. (a) Consider the random walk problem. Assume that tossings of a coin occur every $T$ seconds. At each tossing we take a step to the right if heads show, to the left if tails show. Let $X(t)$ be the position after $t$ seconds. Evaluate $E(x(t))$ and $E(x^2(t))$ for the stochastic process $x(t)$.

(b) Consider the process $x(t) = A \cos wt + B \sin wt$, where $A$ and $B$ are uncorrelated random variables each with mean 0 and variance 1 and $w$ is a positive constant. Is $x(t)$ covariance stationary? Discuss it with all the details.
Appendix 30

Table 1. Values of the Standard Normal Distribution Function.

<table>
<thead>
<tr>
<th>x</th>
<th>0</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>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>0.1</td>
<td>0.0009</td>
<td>0.0048</td>
<td>0.0100</td>
<td>0.0166</td>
<td>0.0239</td>
<td>0.0320</td>
<td>0.0411</td>
<td>0.0510</td>
<td>0.0616</td>
<td>0.0730</td>
</tr>
<tr>
<td>0.2</td>
<td>0.0019</td>
<td>0.0097</td>
<td>0.0208</td>
<td>0.0339</td>
<td>0.0490</td>
<td>0.0664</td>
<td>0.0856</td>
<td>0.1064</td>
<td>0.1289</td>
<td>0.1533</td>
</tr>
<tr>
<td>0.3</td>
<td>0.0029</td>
<td>0.0149</td>
<td>0.0333</td>
<td>0.0554</td>
<td>0.0810</td>
<td>0.1095</td>
<td>0.1399</td>
<td>0.1730</td>
<td>0.2089</td>
<td>0.2480</td>
</tr>
<tr>
<td>0.4</td>
<td>0.0039</td>
<td>0.0200</td>
<td>0.0462</td>
<td>0.0791</td>
<td>0.1163</td>
<td>0.1574</td>
<td>0.2019</td>
<td>0.2494</td>
<td>0.2999</td>
<td>0.3543</td>
</tr>
<tr>
<td>0.5</td>
<td>0.0049</td>
<td>0.0251</td>
<td>0.0588</td>
<td>0.0994</td>
<td>0.1439</td>
<td>0.1910</td>
<td>0.2410</td>
<td>0.2938</td>
<td>0.3496</td>
<td>0.4094</td>
</tr>
<tr>
<td>0.6</td>
<td>0.0059</td>
<td>0.0302</td>
<td>0.0712</td>
<td>0.1203</td>
<td>0.1675</td>
<td>0.2167</td>
<td>0.2680</td>
<td>0.3219</td>
<td>0.3786</td>
<td>0.4383</td>
</tr>
<tr>
<td>0.7</td>
<td>0.0069</td>
<td>0.0352</td>
<td>0.0835</td>
<td>0.1410</td>
<td>0.1901</td>
<td>0.2413</td>
<td>0.2943</td>
<td>0.3491</td>
<td>0.4067</td>
<td>0.4673</td>
</tr>
<tr>
<td>0.8</td>
<td>0.0079</td>
<td>0.0402</td>
<td>0.0956</td>
<td>0.1614</td>
<td>0.2112</td>
<td>0.2630</td>
<td>0.3164</td>
<td>0.3715</td>
<td>0.4285</td>
<td>0.4904</td>
</tr>
<tr>
<td>0.9</td>
<td>0.0088</td>
<td>0.0452</td>
<td>0.1075</td>
<td>0.1816</td>
<td>0.2317</td>
<td>0.2840</td>
<td>0.3378</td>
<td>0.3933</td>
<td>0.4510</td>
<td>0.5137</td>
</tr>
</tbody>
</table>

*W. L. Lindley, Statistical Theory, 1960.*
<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Write short notes on:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i.  Software Failure Vs. Hardware Failure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ii. Real Time Software</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iii. CASE</td>
<td></td>
</tr>
<tr>
<td>1(b)</td>
<td>Discuss the activities performed during the support phase of software engineering.</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>OR</strong></td>
<td></td>
</tr>
<tr>
<td>1'(a)</td>
<td>With the help of a diagram, discuss the common process framework that characterizes a software process.</td>
<td></td>
</tr>
<tr>
<td>1'(b)</td>
<td>Discuss some of the practitioner’s myths associated with software development.</td>
<td></td>
</tr>
<tr>
<td>2(a)</td>
<td>What do you understand by process maturity? How is process maturity assessed for a software development organization?</td>
<td></td>
</tr>
<tr>
<td>2(b)</td>
<td>Discuss the RAD process model. What are the advantages and drawbacks of using this model?</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>OR</strong></td>
<td></td>
</tr>
<tr>
<td>2'(a)</td>
<td>What is meant by Component Based Software Engineering? Explain with the help of a suitable diagram.</td>
<td></td>
</tr>
<tr>
<td>2'(b)</td>
<td>What factors should be taken into account while selecting a process model for the development of a specific software project?</td>
<td></td>
</tr>
</tbody>
</table>
3(a) What are the 4 P's of software project management? Why are they important?

3(b) What are the factors that should be considered when planning the structure of software engineering teams? Discuss the different team structures suggested by Mantei in the light of above factors.

OR

3'(a) What are the pros and cons of using Lines of Code (LOC) and Function Point (FP) measures to derive productivity metrics? How are the two approaches reconciled?

3'(b) The following table indicates the various tasks involved in completing a software project, the corresponding activities, and the estimated effort for each task in person-months.

<table>
<thead>
<tr>
<th>Notation</th>
<th>Activity</th>
<th>Effort in person-months</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>Requirements specification</td>
<td>1</td>
</tr>
<tr>
<td>T₂</td>
<td>Design</td>
<td>2</td>
</tr>
<tr>
<td>T₃</td>
<td>Code actuator interface module</td>
<td>2</td>
</tr>
<tr>
<td>T₄</td>
<td>Code sensor interface module</td>
<td>5</td>
</tr>
<tr>
<td>T₅</td>
<td>Code user interface part</td>
<td>3</td>
</tr>
<tr>
<td>T₆</td>
<td>Code control processing part</td>
<td>1</td>
</tr>
<tr>
<td>T₇</td>
<td>Integrate and test</td>
<td>6</td>
</tr>
<tr>
<td>T₈</td>
<td>Write user manual</td>
<td>3</td>
</tr>
</tbody>
</table>

The precedence relation \( T₁ \leq \{ T₂, T₃ \} \) implies that the task \( T₁ \) must complete before either task \( T₂ \) or \( T₃ \) can start. The following precedence relation is known to hold among different tasks: \( T₁ \leq T₂ \leq \{ T₃, T₄, T₅, T₆ \} \leq T₇ \)

a) Draw the activity network representation of the tasks.

b) Determine the slack time for every task and find the Critical Path.

c) Develop the Gantt chart representation for the software project.

4(a) Define software reliability and software availability in terms of probability. How are they measured?

4(b) What are the techniques used in statistical Software Quality Assurance? Explain?
5(a) What are the key features of a good software design? Explain.

5(b) Draw the Control flow graph for the pseudo code given below. Identify the various bounded regions of the graph and find the cyclomatic complexity of the pseudo code.

<initialization statements>

While (condition) AND (condition)
{
  <statement>
  <statement>
  If (condition) AND (condition)
  {
    then
    <statement>
    <statement>
    else
    <statement>
    <statement>
  }
}
If (condition)
{
  <statement>
  <statement>
}
M. TECH. (I SEMESTER) EXAMINATION
COMPUTER SCIENCE AND ENGINEERING (SOFTWARE ENGINEERING) - SELECTED TOPICS IN COMPUTER SYSTEMS
CO-602

Maximum Marks: 60 Duration: Three Hours

Attempt any FIVE questions.
Assume suitable data if missing.
Notations used have their conventional meaning.

1. Prove each of the following:
   (a) Union of two regular languages is regular. [03]
   (b) Concatenation of two regular languages is regular. [03]
   (c) Kleene closure of a regular language is regular. [03]
   (d) Complement of a regular language is regular. [03]

2.(a) Discuss the two properties of procedures that make them more advanced than primitive operators. Discuss how similarly the two properties are manifested in ADTs that make them more advanced than primitive data types. [06]

2.(b) Discuss the ADT TREE along with its operations. Consider an operation to build a tree with root node labelled v and subtrees T₁, T₂, ..., Tₙ for any integer i ≥ 1. Write a C-language based implementation of the operation CREATE(v, T₁, T₂, ..., Tₙ). [06]

3. (a) Write the Substitution Theorem for CFLs and use it to prove that CFLs are closed under union, concatenation, and closure. [06]

3.(b) Design a PDA to accept the language \( \{0^n1^n | n \geq 1\} \). [06]

4.(a) Write a regular expression for the set of strings of 0's and 1's such that every pair of adjacent 0's appears before any pair of adjacent 1's. Convert the regular expression to an equivalent \( \epsilon \)-NFA, and then to a DFA. [06]

4.(b) Design a DFA that accepts strings representing binary numbers divisible by 3. Find out the regular expression for the language accepted by the DFA using state elimination method. [06]

5. Write the problem solving approach, the end of which results in an algorithm. Discuss where the ADTs come into picture, and where the data structures appear in Contd....2.
6. (a) Explain the diagonalization language $L_d$ and discuss why there is no TM (Turing Machine) that accepts $L_d$.

6(b) Discuss the "halting" of a TM. Explain what are recursive languages and recursively enumerable languages.

7. (a) Design a TM that takes as input a number $N$ written in binary, and adds 1 to it in binary. Take the following two as the representative transitions of the TM:

$q_010101 \rightarrow^* q_f10110$ and $q_011111 \rightarrow^* q_f10000$.

7. (b) Write a short technical note on space complexity.
2014-15
M.TECH. (AUTUMN SEMESTER) EXAMINATION
COMPUTER ENGINEERING
INTERACTIVE COMPUTER GRAPHICS
CO-609

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</td>
<td>Write brief answers for the following:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Aspect Ratio</td>
<td>[12]</td>
</tr>
<tr>
<td></td>
<td>ii) Differentiate between HD and FHD displays</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iii) Differentiate between a normal LCD and an LED display in the present context</td>
<td></td>
</tr>
<tr>
<td></td>
<td>iv) Operating principle of Liquid Crystal Displays with illustrations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>v) Field of view of a camera</td>
<td></td>
</tr>
<tr>
<td></td>
<td>vi) Synthetic Camera Model</td>
<td></td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1'</td>
<td>Explain the concept of Affine Space and Euclidean Space. How are points, lines, planes expressed in Affine Space? Also define a frame and concept of dimension in space.</td>
<td>[12]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2(a)</td>
<td>Describe homogenous co-ordinate representation. What are its advantages?</td>
<td>[06]</td>
</tr>
<tr>
<td>2(b)</td>
<td>A line is specified by ( y = mx + c ). Determine the affine transformation that reflects a two dimensional point about this line.</td>
<td>[06]</td>
</tr>
</tbody>
</table>

OR

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2'</td>
<td>List the steps and determine the transformation that rotates an object by 45 degrees about the line passing through the origin and the point ((1, 3, 5)).</td>
<td>[12]</td>
</tr>
</tbody>
</table>

Contd...
3(a) Give the taxonomy of Planar Geometric Projections and illustrate with suitable examples. [06]

3(b) Derive Normalized Orthogonal Projection matrix for the view volume depicted in Figure 1.

\[
\begin{align*}
\text{(left, bottom, -near)} & \quad \text{(right, top, -far)} \\
\{0, 0, -1\} & \quad \{1, 1, -1\} \\
\{1, -1, 1\} & \quad \{-1, -1, 1\}
\end{align*}
\]

Figure 1.

4(a) What are the properties of light sources and surfaces with reference to shading? Explain Phong Illumination model. [06]

4(b) Distinguish between Gouraud and Phong shading techniques. [06]

5(a) Define clipping and explain Cohen-Sutherland Line clipping algorithm. [06]

5(b) Describe Painter's algorithm for hidden surface removal. What are its limitations? [06]