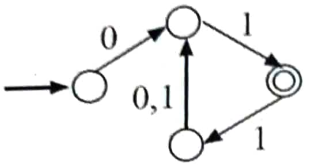
National Institute of Technology, Silchar
End-Semester (UG) Examination, May ' 2019
Subject Code : CS-1204, Subject: Formal Languages & Automata Theory
Semester: 4^{th} . Branch: Computer Sci. &Engg.
Duration: Two Hour. Total Marks: 50

Figure in the right hand margin indicates full marks for the question.
(Answer any FIVE)

1. (a) Consider the following NFA (over the alphabet {0, 1}).



i) What is the shortest string accepted by this NFA? 1+
ii) Let L denote the set of all strings accepted by this NFA. Write a regular expression for L. 2+
iii) Find equivalent NFA for complement of the language defined in (ii). 2

(b) Answer the following giving brief justifications. Take $\Sigma = \{0, 1\}$ 5
i) Is $L = \{\alpha\beta\alpha\gamma \mid \alpha, \beta, \gamma \in \Sigma^*, |\beta| = |\gamma|\}$ regular or not?
ii) Is $L = \{\alpha\beta\alpha\gamma \mid \alpha, \beta, \gamma \in \Sigma^*, \alpha \neq \lambda, |\beta| = |\gamma|\}$ context-free or not?

2. (a) Consider the context-free grammar G over {a, b}, with start symbol S, and with the following productions. 6
$S \rightarrow aaB \mid Abb,\ A \rightarrow a \mid aA,\ B \rightarrow b \mid bB$
What is L(G)? Prove that this CFG is ambiguous and Design an unambiguous context-free grammar for L(G).

(b) Show that "The family of context-free languages is not closed under intersection and complementation". 4

3. (a) Eliminate all useless productions from the grammar below 4
$S \rightarrow a \mid aA \mid B \mid C,\ A \rightarrow aB \mid \lambda,\ B \rightarrow Aa,\ C \rightarrow cCD,\ D \rightarrow ddd$
What language does this grammar generate?

(b) Find a regular expression for the language 6
$L = \{w \in \{a,b\}^* : n_a(w)$ is even and $n_b(w)$ is odd $\}$. $n_a(w)$, $n_b(w)$ represent number of a's and b's in string w respectively.

4. (a) Find a regular grammar for the language $L = \{w : n_a(w)$ and $n_b(w)$ are both even$\}$ 5

(b) Find a regular expression for the set $\{a^n b^m : (n+m)$ is even$\}$. 5

5. (a) Show that "Given a context-free grammar G = (V,T,S,P), there exists an algorithm for deciding whether or not L(G) is empty". 3

(b) State and prove pumping lemma for infinite regular languages. 3+
Prove that $L = \{a^n b^l a^k : k \geq n + 1\}$ is not regular. 4

6. (a) Construct an NPDA that accept the language $L = \{ w : n_a(w) = 2n_b(w) \}$ 5

(b) Show that "If L is a regular language on the alphabet Σ, then there exists a right-linear grammar $G = (V,\Sigma,S,P)$ such that $L = L(G)$. 5

National Institute of Technology, Silchar

Re-End-Semester (UG) Examination, 2019

Subject Code : CS-1204, Subject: Formal Languages & Automata Theory

Semester: 4^{th} . Branch: Computer Sci. &Engg.

Duration: Two Hour. Total Marks: 50

Figure in the right hand margin indicates full marks for the question.

(Answer any FIVE)

1. (a) What is a derivation tree? Show it with a suitable example. 2

(b) Give a derivation tree for w = abbbaabbaba for the grammar 3

$S \rightarrow ABb$, $A \rightarrow aaBb$, $B \rightarrow bbAa$, $A \rightarrow \lambda$

Use the derivation tree to find a leftmost derivation.

(c) Find a context-free grammar for the language $L = \{ a^n b^m c^k : k = n + m \}$ 5

2. (a) Design a DFA to accept the language $L = \{ awa \mid w \in \{a,b\}^* \}$. Show that L^2 is regular language. 6

(Hint : Only draw the transition diagram, and clearly indicate the start state and the final state(s).)

(b) Let G be the context free grammar with following productions: 4

$S \rightarrow aA \mid aBB$, $A \rightarrow aaA \mid \lambda$, $B \rightarrow bB \mid bbC$, $C \rightarrow B$

Remove all unit-productions, all useless-productions and all λ productions from G?

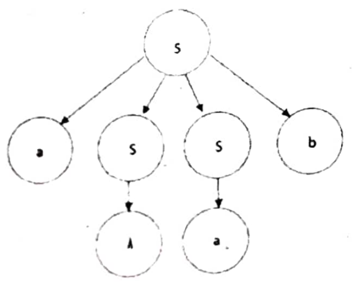
3. (a) What is an inherently ambiguous language? Give an example of it. 2

(b) Show that the following grammar is ambiguous. 4

$S \rightarrow AB \mid aaB$, $A \rightarrow a \mid Aa$, $B \rightarrow b$

(c) Construct an unambiguous grammar equivalent to the grammar of the above grammar. 4

4. (a) Consider the following derivation tree. 5 + 2 + 3



i) Find a grammar G for which this is the derivation tree of the string 'aab'?

ii) Find two more sentences of L(G).

iii) Find a sentence in L(G) that has a derivation tree of height five or larger.

5. (a) Convert the following grammar (over the alphabet {a,b}) to the Chomsky normal form. 4

$S \rightarrow AB \mid aB$, $A \rightarrow aab \mid \lambda$, $B \rightarrow bbA$

(b) Construct an npda that accepts the language generated by the grammar 6

$S \rightarrow aSbb \mid aab$

6. (a) Prove that $L = \{ a^n : n \text{ is the product of two prime numbers} \}$ is not regular. 5

(b) Prove that any context-free grammar $G = (V,T,S,P)$ with $\lambda \notin L(G)$ has an equivalent grammar in Chomsky normal form. 5

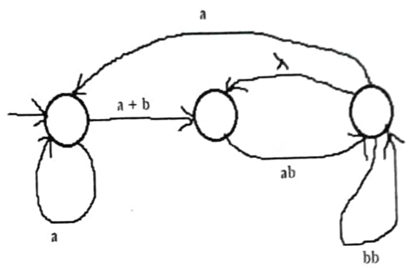
National Institute of Technology, Silchar
Mid-Semester Examination, March 2019

Subject Code: CS-1204,
Semester: 4^{th},
Duration: 60 Minute,

Subject: Formal Language and Automata Theory
Department: Computer Science and Engineering
Total Marks: 30

Figure in the right hand margin indicates full marks for the question.
Answer all three Questions.

1. Consider the following generalized transition graph.



   (a) Find an equivalent generalized transition graph with only two states. What is the language accepted by this graph?

   (b) Construct a NFA with 3 states that accepts the language $L(r)$ where $r = (ab^*)^* + (ba^*)^*$.

   (c) Find a DFA for the language consisting of all 0-1 strings such that at every point in the string the number of 1s minus the number of 0s is zero, one, or two.

   $((3+1)+3+3)$

2. (a) Define indistinguishable and distinguishable state pairs for a DFA.

   (b) Prove that the family of regular languages is closed under set difference and complement oprations.

   (c) Let the alphabet $\Sigma = \{a, b\}$. Do the following regular expressions represent the same language? If yes, justify, otherwise give a word which is in one language and not in the other
   (a) a^* and $(aa)^* + a(aa)^*$
   (b) a^*b^* and $(a+b)^*(ab)^*$

   $(2+(2+2)+(2+2))$

3. (a) State pumping lemma and discuss the strategy to apply it for non-regular language $L = \{0^n1^m0^{n+m} | m \geq 1 n \geq 1\}$.

   (b) Construct right- and left-linear grammars for the language $L = \{a^nb^m : n \geq 2, m \geq 3\}$.

   $((2+3)+(3+2))$

National Institute of Technology Silchar
Mid-Semester (UG) Examination, March-2019

Subject Code: CS1205
Semester: 4thSemester
Duration: One Hour

Subject: Signal & Data Communication
Department: CSE
Total Marks: 30

Figure in the right hand Margin indicates full marks for the question

All questions are compulsory.

1) A) Simplify the integral [2]

$$\int_{-\infty}^{\infty} x(t)\delta(at-b)dt$$

B) Find the even and odd component of the signal [2]

$$x(t) = \sin t + 2\sin t + 2\sin^2 t \cos t$$

C) Find the fundamental period for the signal [4]

$$x(n) = (-1)^{n^2}$$

D) Calculate the power of u(t) signal. [2]

2) A) Check the system in terms of causality and time-invariant. [3]

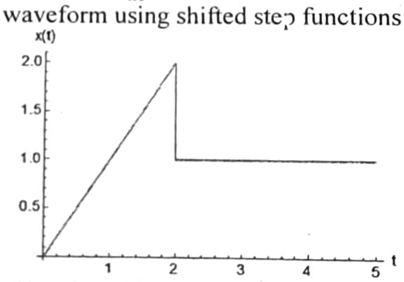
$$\sin(t+1).x(t-1)$$

B) Define the following with formula [4]

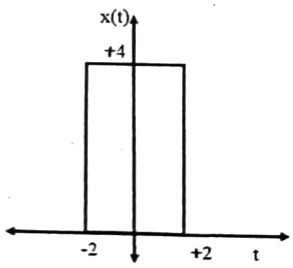
i) Linear system
ii) Causal system
iii) Stable system
iv) Time-varying system

C) Determine whether the system $\frac{dy(t)}{dt} + 3y(t) + 4 = x(t)$ is linear or nonlinear [3]

3) A) Represent the given waveform using shifted step functions [4]



B) For the given signal x(t) , plot x(-3t+2) [3]



C) Find the energy of $e^{-at}.u(t)$, for a>0 [3]

***

National Institute of Technology, Silchar
End-Semester (UG) Examinations, May' 2019

Subject Code: CS-1205 | Subject: Signals & Data communication
Semester: 4th | Department: CSE
Duration: Two Hours | Total Marks: 50

Figure in the right hand margin indicates full marks for the question.

Answer any 5 (five) questions.

[1] **[A]** Define modulation. Explain AM and derive different components of it. [4]

[B] Find different line coding as below for the data 010011 [6]

a) Manchester coding
b) Different Manchester coding
c) RZ
d) MLT

[2] **[A]** The received Codeword is 10101001110. Check the correctness of the received codeword using Hamming code method. Also find the corrected data if erroneous data is received. [3]

[B] Explain CRC method with an example. [2]

[C] Write short node on Frame Relay and its working principle [3]

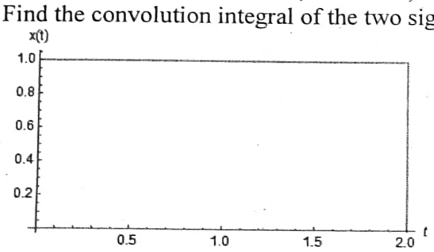
[D] What is the maximum capacity of the media with bandwidth of 1000khz and signal to noise ratio of 30dB? [2]

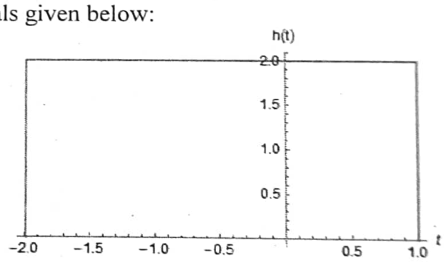
[3 **[A]** Briefly explain different methods of Digital-To-Analog Modulation. [3]

[B] Why do we need Multiplexing in data communication? List the different types of multiplexing techniques. [3]

[C] Define the terms: Bandwidth, Baud rate, SNR, Baseline wandering [4]

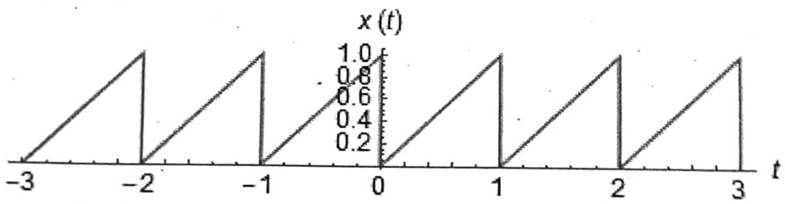
[4] **[A]** Find the convolution integral of the two signals given below: [6]





[B] Write properties of Fourier series. [4]

[5] **[A]** Find the Fourier series for the periodic signal $x(t) = t \; for \; 0 \leq t < 1$ and repeat every 1 unit of time as below. [5]



[B] What is the input signal $x(n)$that will generate the output sequence $y(n) = \{\underset{\uparrow}{1}, 5, 10, 11, 8, 4, 1\}$ for a system with impulse response $h(n) = \{\underset{\uparrow}{1}, 2, 1\}$ [5]

[6] **[A]** Write the formula of trigonometric Fourier Series. [2]

[B] What is Dirichlet conditions? [2]

[C] What is Gibb's Phenomenon [2]

[D] Find the linear convolution of $x(n) = \{1, 2, 3, 4, 5, 6\} with \; y(n) = \{2, -4, 6, 8\}$ [4]

***

End-Semester (UG) Examination, May '2019

Subject Code: MA 1251, Subject: Introduction to Stochastic Process

Semester: 4^{th}, Department: CSE

Duration: Two Hours, Total Marks: 50

Figure in the right hand margin indicates full marks for the question

Answer any five questions.

1. (a) Find autocovariance function and autocorrelation function of Poisson Process. **4+1**

(b) If $X(t) = A\cos ct + B\sin ct$ and $Y(t) = B\cos ct - A\sin ct$, where c is a constant, A and B are uncorrelated random variables with mean 0 and variance 1. Examine whether $\{X(t)\}$ and $\{Y(t)\}$ are jointly widen -sense stationary or not. **5**

2.(a) Define Markov chain and Random Walk. Give an example of each. Show that a Simple random walk is a Markov chain. **2+2+3**

(b) What do you mean by Strictly stationary process? Explain with example. What is the difference between Strictly stationary process and wide sense stationary process **3**

3. (a) Define transition probability matrix. State and prove Chapman Kolmogorov Equation. **1+4**

(b) The transition probability matrix of a Markov chain $\{X_n\}$ with states 1, 2, 3 is **5**

$P=\begin{pmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix}$ Is the Markov chain irreducible? Is the state 1 transient?

4. (a) A housewife buys 3 kinds of cereals A, B and C. She never buys the same cereal in successive weeks. If she buys cereal B, the next week she buys cereal C. However if she buys A or C, the next week she is 3 times as likely to buy B as the other cereal. In long run, how often does she buy cereal B ? Suppose on the first week of a month, she buys cereal B, what is the probability that she buys cereal A on third week. **3+3**

(b) Customers arrived at a bank according to a Poisson process with a mean rate of 3 per min. Find the probability that **2+2**

(i) during a time interval of 5 minute no customer has arrived.

(ii) time interval between two consecutive arrival is more than 2 minutes.

5. (a) A system consists of 3 machines and 2 repairmen. The amount of time that an operating machine works before breaking down is exponentially distributed with mean 7 hours. The amount of time that it takes a single repairman to fix a machine is exponentially distributed with mean 6 hrs. Only one repairman can work on a failed machine at any given time. Let X(t) be the number of machines in operating at time t. **3+2**

(i) Calculate the long run probability of X(t).

(ii) If an operating machine produces 50 units of output per hour, what is the long run output per hour from the factory?

(b) If $X(t) = A\sin wt$, where A is a uniform random variable over [1, 7] and w is a constant. Find E[$X(t)$] and $R_X(t, s)$. **2.5+2.5**

6. (a) Arrivals at a telephone booth are considered to be Poisson with an average time of 10 minute between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 5 minute. **2+2+2**

(i) Find the average number of persons in the system and in the queue.

(ii) What is the probability that a person arriving at the booth will have to wait in the queue?

(iii) What is the probability that it will take for a person more than 10 minutes altogether to wait for the phone and complete his call.

(b) The density function of the time to failure of an appliance is $f(t) = 50(t+5)^{-3}$; t (>0) is in years. Find the reliability function and the MTTF. **2+2**

****

MID-SEM EXAM., MARCH 2019, NIT SILCHAR
Class: B. Tech., Branch: CSE, SEMESTER: FOURTH
Sub.: Introduction to Stochastic Process (MA 1251)

Full Marks: 30 **Time: 1hr.**

Answer ALL questions.

The tabulated values which may be useful in solving the questions are given below. Use the appropriate one as and when required.

- $t_{0.1}$=1.345 at df 14 for two tailed test
- $\varphi^{-1}(0.42) = 1.405, P(0 < z < 0.56) = 0.2123, P(0 < z < 0.28) = 0.1103$
- $F_{0.05} = 3.35$ at df (10, 8)
- $t_{0.05}$=1.35 at df 13 for RTT.
- $\chi^2_{0.05} = 11.07$ at df 5
- $\phi(0.5) = 0.6915$
- $\phi(1.25) = 0.8944$

1. Write five important properties of a Normal Distribution. If the mean and variance of a Normal distribution are 3 and 16 respectively, find $P(-2 \le X \le 1)$. [5]

2. Explain the following terms with suitable example/diagram: [5]
   i. Fiducial limit
   ii. Level of significance
   iii. Sampling distribution
   iv. t-distribution
   v. 'Standard error' in Sampling distribution

3. A population consists of four numbers 8,7,5,4. Consider all possible samples of size two with replacement. Find the standard deviation of sampling distribution of means. Verify the result by using suitable formulae. [5]

4. In a year, there are 956 births in a town A of which 52.5% were males, while both in towns A and B combined, this proportion in a total of 1406 births was 0.496. Is there any significant difference in the proportion of male births in the two towns?

5. A survey of 320 families with 5 children each, revealed the following distribution. [5]

No. of boys	5	4	3	2	1	0
No. of girls	0	1	2	3	4	6
No. of families	14	56	110	88	40	12

Is the result consistent with the hypothesis that male and female births are equally probable?

6. Sample for two types of electric bulbs were tested for length of life and the following data were obtained. [5]

	Type I	Type II
Sample size	8	7
Sample means	1.234 hrs	1.036 hrs
Sampled s.d.	36 hrs.	40 hrs.

Is the difference in the means sufficient to warrant that Type I is superior to Type II in terms of length of life?

---------------------X---------------------

End-Semester (UG) Re-Examination, July '2019

Subject Code: MA 1251,
Semester: 4^{th},
Duration: Two Hours,

Subject: Introduction to Stochastic Process
Department: CSE
Total Marks: 50

Figure in the right hand margin indicates full marks for the question.

Answer any five questions.

1. (a) What do you mean by state space of a stochastic process? Give an example of (i) Stochastic process having finite state space (ii) Continuous time discrete state space stochastic process. — 3

(b) Find mean, autocorrelation function and first order probability distribution of simple Random Walk. — 1+2+4

2. (a) A gambler has Rs 3. At each play of the game, he loses Rs 1 with probability 2/3, but wins Rs 1 with probability 1/3. He stops playing if he lost his initial amount of Rs 3 or he wins at least Rs 2. Write down the tpm of the associated Markov chain. Find the probability that there are at least 3 rounds of the game. — 5

(b) A banker has three different suits he wears to work, a navy blue one, a gray one and a beige one. He never wears the same suit two days in a row. If he wears the navy blue suit one day he always wears the gray one the next day. If he wears either the gray or beige suits one day he is twice as likely to wear the navy blue one rather than the other one the next day. In the long run how often does he wear each suit? If he wears the grey suit on Monday of a particular week, what is the probability that he will wear again the same suit on Wednesday of that week? — 2.5+2.5

3. (a) The number of failures $N(t)$ which occur in a computer network over the time interval $[0,t)$ can be described by a Poisson process $\{N(t): t\geq 0\}$. On an average there is a failure after every 4 hours. — 2.5+2.5

(i) What is the probability of at most one failure in $[0, 8)$?
(ii) Find the probability that interval between two consecutive failure is more than 5 hrs.

(b) The transition probability matrix of a Markov chain $\{X_n\}$ with states 1, 2, 3 is — 5

$$P=\begin{pmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{2} & 0 & \frac{1}{2} \\ 1 & 0 & 0 \end{pmatrix}$$

Is the Markov chain irreducible? Is the state 2 transient?

4. (a) If $X(t) = A\sin(wt + Y)$, where Y is a uniform random variable over $(0, 2\pi)$ and w is a constant, examine whether $\{X(t)\}$ is a wide -sense stationary process or not. — 5

(b) A system consists of 3 machines and 2 repairmen. The amount of time that an operating machine works before breaking down is exponentially distributed with mean 5 hours. The amount of time that it takes a single repairman to fix a machine is exponentially distributed with mean 3 hrs. Only one repairman can work on a failed machine at any given time. Let X(t) be the number of machines that are down. — 3+2

(i) Calculate the long run probability of X(t).
(ii) What is the average number of machines not in use?

5. (a) What is a counting process? Explain with example. When a counting process is said to be a Poisson process? — 2.5+1.5

(b) A petrol pump station has 4 pumps. The service times follows the exponential distribution with a mean rate of 5 min and cars arrive for service in Poisson process at the rate of 25 cars per hour. (i) What is the probability that an arrival would have to wait in line? (ii) Find the average number of cars in the system. — 3.5+2.5

6. (a) Customers arrive at a bank according to a Poisson process with an average time of 12 minute between one arrival and the next. The length of service is assumed to be distributed exponentially with mean 6 minute. (i) What is the probability that a person arriving in the bank will have to wait in the queue? (ii) What is the probability that more than 5 customers are in the system? (iii) If a customer arrives at 11 AM, at what time he can expect to finish his job and come out? — 3+2+2

(b) An electronic device has failure time density function (t measured in hours) $f(t) = .002e^{-.002t}$, $t>0$. Find MTTF. — 3

****

National Institute of Technology Silchar

Special Examinations (UG), Feb' 2018

Subject code: CS-1204
Semester: 4th,
Duration: Three Hours,

Subject: Formal Languages and Automata Theory
Department: CSE
Total Marks: 80

Figure in the right hand margin indicates full marks for the question.

Answer any eight Questions.

1.	[a] Is the following grammar Type 0, Type 1, Type 2, or Type 3? $S \to AaBC, BC \to \epsilon,\ aB \to aaB,\ A \to \epsilon$ [b] Give the regular expression for the set of all strings with even number of a's followed by odd number of b's. [c] Construct the NFA that accepts the languages generated by the R.E. $ab^*aa + bba^*ab$. [d] Design a FA which accepts set of strings containing exactly four 1's in every string over alphabet {0, 1}.	(2+2+3+3)
2.	[a] Differentiate DFA with NDFA with a suitable example. [b] Compare Moore and Mealy machines. [c] Give a regular expression over (0, 1) for representing the set L of strings in which every 0 is immediately followed by at least two 1's.	(3+4+3)
3.	[a] Prove the pumping lemma for regular expression. [b] Prove (1 + 00*1) + (1 + 00*1) (0 + 10*1)* (0 + 10*1) = 0*1 (0 + 10*1)	(5+5)
4.	[a] What are the closure properties of context free grammar? [b] Prove the pumping lemma for regular expression.	(5+5)
5.	[a] Show whether the grammar is ambiguous or not, $S \longrightarrow aSSb \mid bSSa \mid \epsilon$ [b] Design a top-down parser for the following CFG $S \longrightarrow XY,\ X \longrightarrow aX \mid b,\ Y \longrightarrow bY \mid a$	(4+6=10)
6.	[a] State pumping lemma for context-free grammars. [b] What is the problem of null productions in CFG? [c] What is the problem of unit productions in CFG? [d] Construct a deterministic pushdown automata that accepts the language $L = \{a^n c b^{2n} \mid n>=1\}$ over the alphabet $\sum = \{a, b, c\}$	(2+1+1+6=10)
7.	[a] Remove the ϵ-production from the following grammar $S \to ABAC,\ A \to aA \mid \epsilon,\ B \to bB \mid \epsilon,\ C \to c.$ [b] Convert the following grammar into GNF, $S \to AB,\ A \to BS \mid b,\ B \to SA \mid a.$	(5+5)
8.	[a] What is a derivation tree? [b] How can the drawback of finite automata be overcome by push down automata? Explain with an example. [c] Construct a PDA accepting $\{a^n b^m a^n \mid m, n>=1\}$ by null store.	(2+3+5)
9.	[a] Show that if L is regular, so is L^R. [b] What is the advantage of normal form in context-free grammar? [c] If L1 is a context free language and L2 is a regular language then L1 - L2 is a context-free Language. Prove or disprove. [d] What are the two initial steps to be performed for making a CFG fit for Top-down parsing? Explain with example.	(2+2+2+4)

National Institute of Technology Silchar

Mid-Semester (UG) Examination, March' 2018

Subject code: CS-1204
Semester: 4th,
Duration: One Hour,

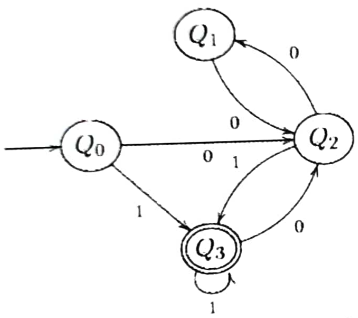
Subject: Formal Languages and Automata Theory
Department: CSE
Total Marks: 30

Figure in the right hand margin indicates full marks for the question.

1. [a] What is the necessity of finding n-equivalence machine? [b] Are NFA's and DFA's equivalent in power? Give examples in support. [c] Give regular expression for the set of all strings over {0,1} with at most two occurrences of substring 00. [d] Construct the grammar for L(G)= $\{a^i b^{2i} \mid i>=0\}$

(2+3+2+3)

2. [a] Define a grammar with variables Q_0, Q_1, Q_2, and Q_3, that corresponds to the following NFA?



[b] Show that "Given standard representations of two regular languages L_a and L_b, there exists an algorithm to determine whether or not $L_a = L_b$". [c] Construct finite automata equivalent to the regular expression (0 + 1)* (00 + 11) (0 + 1)*. (4+3+3)

3. [a] Show that regular sets are closed over union operation. [b] For the language L = { xwx^R | x, w Ɛ {0,1}* , $|x| \neq 0$ }, decide whether the language is regular, and prove your answer by pumping lemma. [c] Suppose L_1 and L_2 are two regular languages for finite automata, M_1 and M_2 respectively. Determine finite automata, M for $L = L_2 - L_1$

M1		
Current State	Input Symbols	
	0	1
->q_0	q_1	q_0
q_1	q_2	q_0
q_2	q_2	q_2

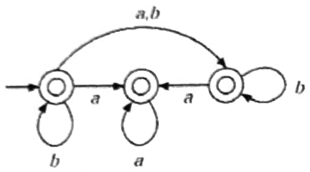
M2		
Current State	Input Symbols	
	0	1
->p_0	p_1	p_0
p_1	p_1	p_2
p_2	p_1	p_0

(3+4+3)

National Institute of Technology, Silchar
End-Semester (UG) Examination, May ' 2018
Subject Code : CS-1204, Subject: Formal Languages & Automata Theory
Semester: 4[th] . Branch: Computer Sci. & Engg.
Duration: Two Hour. Total Marks: 50

Figure in the right hand margin indicates full marks for the question.
(Answer any FIVE)

1. (a) Consider the following NFA (over the alphabet {a,b}). **(1+ 2+ 2)**



i) What is the shortest string not accepted by this NFA?
ii) Let L denote the set of all strings not accepted by this NFA. Write a regular expression for L.
iii) Convert the regular expression of Part (ii) to an equivalent NFA.

(b) Let L denote the language over the alphabet {a,b} such that w ε L if and only if $|w| \geq 2$, the second symbol of w is a, and the second last symbol of w is b. Design an NFA to accept L. **(2)**

(c) Show that regular sets are closed over concatenation operation. **(3)**

2. (a) Consider the language $L = \{a^i (bc)^j : i, j \geq 0 \text{ and } i \geq j\}$, over $\Sigma = \{a,b,c\}$. Design a context-free grammar for L. Briefly describe the substrings generated by the non-terminal symbols used in your grammar. **(5)**

(b) The production system of a context-free grammar G({S, X, Y}, {0, 1}, S, P) is $S \rightarrow XY$, $X \rightarrow YS \mid 1$ and $Y \rightarrow SX \mid 0$. Create an equivalent grammar in GNF. **(5)**

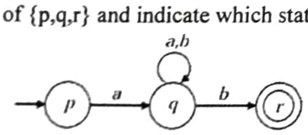
3. (a) Design a DFA to accept the language L = {w ε {a,b,c}* : w starts and ends with the same symbol}. Only draw the transition diagram, and clearly indicate the start state and the final state(s). **(3)**

(b) i) What is ambiguity of grammar? **(1+1+ 2)**
ii) What is recursive inference?
iii) Consider the following grammar G with productions $S \rightarrow aSa \mid bSb \mid \in$.
Give an equivalent grammar removing $\in$ $\{lambda\}$ production.

(c) Consider the following context-free grammar to generate arithmetic expression in one variable a, involving addition and multiplication operations only. Here, S is the start symbol. **(3)**
$S \rightarrow a \mid S + S \mid S \times S$
Draw all the parse trees for the string "$a + a \times a + a$" following this grammar.

4. (a) Describe a procedure for constructing a context-free grammar G for a given arbitrary nondeterministic pushdown automata M such that L(M) = L(G). **(5)**

(b) Convert the following NFA (over {a,b}) to an equivalent DFA. Mark the states of your DFA by subsets of {p,q,r} and indicate which states of your DFA are accessible. **(5)**



5. (a) i) Show that the context-free languages is not closed under intersection. **(2+2)**
ii) Briefly discuss on the basic concepts of languages, grammars and automata. Show how the three are related.

(b) Define deterministic pushdown automata. Give appropriate example. **(2)**

(c) State and prove pumping lemma for regular languages. **(4)**

6. (a) Design a PDA for a language $L = \{a^n b^m a^n \mid m, n \geq 1\}$. **(5)**

(b) Show that the language L = {w ε {a,b,c}* : $n_a(w) = n_b(w) = n_c(w)$} is not context-free. $n_a(w)$, $n_b(w)$ and $n_c(w)$ represent number of a's, b's and c's in string w respectively. **(5)**

National Institute of Technology Silchar

Special Examinations (UG), August 2018

Subject Code: CS-1204
Semester: 4th
Duration: **Three Hours,**

Subject: Formal Languages and Automata Theory
Department: CSE
Total Marks: **80**

Figure in the right hand margin indicates full marks for the question.

Answer any eight Questions.

1. [a] Differentiate DFA with NDFA with a suitable example. [b] Compare Moore and Mealy machines. [c] Give a regular expression over (0, 1) for representing the set L of strings in which every 0 is immediately followed by at least two 1's. (3+4+3)

2. [a] Construct the regular expression for the sets, $\{a^{2n+1} | n > 0\}$. [b] Consider the regular expression (0+1)(0+1) : : : N times. The minimum state finite automaton that recognizes the language represented by this regular expression contains how many states? [c] Construct a minimized DFA for the R.E. 10+(0+11))*1. (3+2+5)

3. [a] State the principle behind the pumping lemma for regular languages. Prove it. [b] Design a FA which accepts set of strings containing exactly four 1's in every string over alphabet {0, 1}. (6+4)

4. [a] What is the drawback of finite automata? And how can it be overcome by push down automata? Explain with an example. [b] Reduce the following grammar to GNF,
S→ 1A|0B, A→ 1AA|0S|0, B→ 0BB|1S|1 ((2+2)+6)

5. [a] What are the non-closure properties of context free grammar? [b] Remove the ∈ -production from the following grammar $S \rightarrow ABAC$, $A \rightarrow aA|\in$, $B \rightarrow bB|\in$, $C \rightarrow c$. [c] What are the two initial steps to be performed for making a CFG fit for the design of top-down parser? Explain with example. (2+4+4)

6. [a] What is the advantage of normal form in context-free grammar? [b] If L1 is a context free language and L2 is a regular language then L1 - L2 is a context-free Language. Prove or disprove. [c] Write the procedure to remove non-terminals which fail to generate terminals in CFG. (2+4+4)

7. [b] How can ambiguity be removed from CFG? [c] Show that the grammar $S \rightarrow a/abSb/aAb \quad A \rightarrow bS/aAAb$ is ambiguous. [c] Write the pumping lemma for context free grammars and prove it. (1+4+5)

8. [a] Use pumping lemma to prove that the language $L = \{0^p | \, p \text{ is a prime number}\}$ is not regular. [b] Write the algorithm to find the regular expression corresponding to a finite automaton. [c] Prove that Arden's theorem has unique solution. (4+3+3)

9. [a] Construct a PDA accepting $\{a^n b^m a^n | m, n>=1\}$ by null store. Construct the corresponding CFG accepting the same set. (10)

National Institute of Technology, Silchar

End-Semester (UG) Examinations, May' 2018

Subject Code: CS-1205, | Subject: Signals and data communication
Semester: 4^{th}, | Department: Computer Sc. & Engg.
Duration: Two Hour, | Total Marks: 50

Figure in the right hand margin indicates full marks for the question.

Answer any five questions.

1. (a) Explain different properties of LTI System. **4**

(b) Consider an LTI system with input $x[n]$ and unit impulse response $h[n]$ specified as follows: **4**

$$x[n] = 2^n u[-n]$$
$$h[n] = u[n]$$

Calculate $y[n]$ using convolution sum.

(c) Distinguish between a signal element and a data element. **2**

2. (a) Find Fourier series coefficients for the following signal and draw corresponding magnitude and phase plot. **4**

$$x(t) = 1 + \sin(\omega_0 t) + 2\cos(\omega_0 t) + \cos(2\omega_0 t + \frac{\pi}{4})$$

(b) Consider the Fourier transform of $e^{-|t|}$ is $\dfrac{2}{1+\omega^2}$ **4**

i. Use appropriate FT properties to find the FT of $te^{-|t|}$.

ii. Use the result from part (i), along with duality property, to determine the FT of $\dfrac{4t}{(1+t^2)^2}$.

(c) Write Parseval's relation in Fourier transform. **2**

3. (a) Consider the following digital data **11000011000000000101** and construct the digital signal using NRZ-L, NRZ-I, Bipolar AMI, Pseudoternary, Manchester, Differential Manchester, B8ZS and HDB3 techniques. **8**

(b) Distinguish between broadband and baseband transmission. **2**

4. (a) Given a message **1011001101** (10 bits) and a divisor **110110** (6 bits). Calculate the message to be transmitted using **Modulo-2 Arithmetic** and **Polynomial**. Show that the received messages are transmitted without error. **4+4**

(b) Define the characteristics of a self-synchronizing signal. **2**

5. (a) Write short notes on: **3x3**

i. OFDM
ii. Delta Modulation with disadvantages
iii. FFHSS

(b) Define quantization error. **1**

6. (a) Name three types of transmission impairment and explain them. **3**

(b) In twisted wired cable the wires are twisted. Give the reason. **1**

(c) Give the advantages and disadvantages of different guided mediums (physical). **4**

(d) What is the maximum data rate of a channel with a bandwidth of 200 KHz if we use four levels of digital signalling? **2**

*****

National Institute of Technology, Silchar

Special Examinations (UG), August-September 2018

Subject Code : CS-1205 | Subject: Signal and Data Communication

Semester: 4^{th} | Department: CSE

Duration: **Three Hours,** | Total Marks : **80**

Figure in the right hand margin indicates full marks for the question.

Answer any eight Questions.

1. Mention how continuous, discrete and digital signals are related. Define Fourier transform. Relate and contrast between LT and ZT. **10**

2. What is modulation and explain the various types of modulation. Why should carrier of a message signal should always be of high frequency? **10**

3. (a) Find the inverse Z-transform of the following function: **6**

$$\frac{z^2 + z}{z^2 - 3z + 4}$$

(b) Find the energy and power of the complex signal. **4**

$$y(t) = \begin{cases} (1+j)e^{j\pi t/2} & , \; for \; 0 \le t \le 10 \\ zero & , \; otherwise \end{cases}$$

4. Consider a source with eight symbols s1,s2,...., s8 with probabilities 0.25,0.21, 0.15, 0.14, 0.0625, 0.0625, 0.0625, 0.0625, respectively. Find the Huffman code and also find the average length and entropy. **10**

5. (a) What is the total delay (latency) for a frame size of 5 MB that is being sent on a link with 10 routers each having queuing time of 2 micro-sec, and a processing time of 1 micro-sec. The length of the link is 2000Km. The speed of light inside the link is $2x10^8$m/sec. The link has a bandwidth of 5Mbps. **5**

(b) A signal has passed through three cascaded amplifiers each with 3dB gain, what is the total gain and how much is the signal amplified. **5**

6. (a) An image has a resolution of 1024x768 pixels ,what is the bit rate of the channel required to send the image assuming 1pixel=8bits. **4**

(b) Sketch the following AMI and Polar RZ encoding scheme for the data 10101101100010 **2**

(c) If a periodic signal is decomposed into five sine waves with frequencies of 100, 300, 500, 700, and 900 Hz, what is its bandwidth . **4**

7. Explain 7 layer of OSI model. What are the causes of transmission impairments and what are the impairments? **10**

8. Mention the advantages of digital communication over analog communication. Explain the significance of layered architecture. **10**

9. What is cyclic redundancy check? Determine the CRC in both sender side and receiver side for the message 10110110 and polynomial 10110. What is burst error and where is it more common. **10**

*****

National Institute of Technology, Silchar
Special Examinations(UG), Feb' 2018

Subject Code : CS-1205, Subject: Signal and Data Communication
Semester: 4th, Department: CSE
Duration: **Three Hours,** Total Marks: **80**

Figure in the right hand margin indicates full marks for the question.

Answer any eight Questions.

1. (a) Define continuous time and discrete time signal with appropriate example. **4**
   (b) Determine whether each $x(t)$ is periodic or not. If periodic find fundamental period. **6**
   i. $x(t)=10\sin(2t)$ ii. $x(t)=15\cos(0.2\pi t)$ iii. $x(t)=\cos\left(\frac{10}{3}\pi t+0.4\right)$

2. (a) Explain different types of system interconnection with their block diagram. **4**
   (b) Find whether the following systems are memoryless, time invariant, Linear, Causal and Stable. **6**
   i. $y(t)=x(t-2)+x(2-t)$ ii. $y(t)=\begin{cases}0 & ,t<0\\ x(t)+x(t-2) & ,t\geq 0\end{cases}$

3. (a) Show that $\delta[n]=u[n]-u[n-1]$ where, $\delta[n]$ is unit impulse and $u[n]$ is unit step discrete signal. **4**
   (b) Determine the convolution sum of given sequences $\{1,2,3\}*\{4,5,6,7\}$. Explain the steps in detail. **6**

4. (a) Find the Laplace Transform of the following functions: **4**
   i. $e^{-at}-e^{-bt}$ ii. te^{-at}
   (b) Write down the various properties of the continuous-time Fourier transform. **6**

5. (a) Differentiate amongst ASK, PSK and QAM **2**
   (b) What is the difference between bit rate and baud rate? **2**
   (c) Write the Shanon capacity of a noisy channel and what is the capacity of an extremely noisy channel? **2**
   (d) Explain Amplitude, frequency and phase Modulation and with a neat sketch. **4**

6. (a) Find the output $y(t)$ for the system described by a differential equation $\frac{dy(t)}{dt}+2y(t)=x(t)$ and the given input is $x(t)=Ke^{3t}u(t)$. **10**

7. (a) Consider the following table: **7**

Code	Message	Probability
000	M1	0.3
001	M2	0.25
010	M3	0.15
011	M4	0.12
100	M5	0.10
101	M6	0.08

   Calculate the efficiency of the above code and also find the Huffman coding for the above code?
   (b) Find the energy and power of the complex signal **3**

$$y(t)=\begin{cases}(1+j)e^{j\pi t/2} & ,0\leq t\leq 10\\ 0 & ,otherwise\end{cases}$$

8. **(a)** Sketch the following encoding schemes for the data 10101101100010 **5**

   i. Manchester

   ii. NRZ-L

   (b) An AM wave is represented by the expression: **5**

   $v = 5(1 + 0.6\cos 6280t)\sin 211 \times 10^4 t$ volts

   i. What are the minimum and maximum amplitudes of the AM wave?

   ii. What frequency components are contained in the modulated wave and what is the amplitude of each component?

9. **(a)** What is cyclic redundancy check? Determine the CRC in both sender side and receiver side for the message 10110110 and polynomial 10110 **6**

   (b) Describe TDMA and CDMA. **4**

*****

National Institute of Technology Silchar

Mid-Semester (UG) Examination, March '2018

Subject Code: MA 1251, Subject: Introduction to Stochastic Process

Semester: 4^{th}, Department: CSE

Duration: One Hour, Total Marks: 30

Figure in the right hand margin indicates full marks for the question.

All questions are compulsory.

1. Consider the Stochastic Process $\{X(t)\}$ defined by $X(t) = Ae^{t} + Be^{-t}$, where A and B are independent uniformly distributed random variables over (0, 1) and (2, 3) respectively. Find mean and autocorrelation function of $\{X(t)\}$. **1+3**

2. The transition probability matrix of a Markov chain $\{X_n\}$ with states 1, 2 , 3 is as follows: **2+2**

$$\begin{pmatrix} \frac{1}{2} & \frac{1}{2} & 0 \\ \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \\ 0 & \frac{1}{3} & \frac{2}{3} \end{pmatrix}$$

The initial distribution is $p^{(0)} = (\frac{1}{5}, \frac{2}{5}, \frac{2}{5})$.

(i) Evaluate $P\{X_3 = 1, X_2 = 2, X_1 = 2, X_0 = 3\}$.

(ii) Find the period of state 3.

3. Show that communication is a transitive relation. **2**

4. A man either drives a car or catches a train to go to office each day. He never goes two days in a row by train but if he drives one day, then the next day he is just as likely to drive again as he is to travel by train. Now suppose that on the first day of the week, the man tossed a fair dice and drove to work if and only if a 6 appeared. Find the probability that **2.5+ 2.5**

(i) he takes a train on the third day,

(ii) he drives to work in the long run.

5 When the mean of marks was 50% and S.D. 5%, then 60% of the students failed in an examination. Determine the 'grace' marks to be awarded in order to show that 70% of the students passed. Assume that the marks are normally distributed.[Given, $\phi^{-1}(0.6) = 0.25, \phi^{-1}(0.3) = -0.52$] **5**

6 Blood glucose levels of obese patients have a mean of 100 with a standard deviation of 15. A researcher thinks that a diet high in raw cornstarch will have a positive or negative effect on blood glucose levels. A sample of 30 patients who have tried the raw cornstarch diet have a mean glucose level of 140. Test the hypothesis that the raw cornstarch had an effect. **5**

7 Consider a Markov chain with transition probability matrix $P = \begin{pmatrix} \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \\ \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{4} & \frac{1}{4} & \frac{1}{2} \end{pmatrix}$ **5**

Find P^n.

****

National Institute of Technology Silchar
Special- Examination, Aug. 2018

Subject Code: MA 1251 | Subject: Introduction to Stochastic Process
Semester: 4^{th} | Branch: CSE
Duration: Three Hours | Total Marks: 80

Figure in the right hand margin indicates full marks for the question.
Answer any eight questions.
Use the given data provided at the end of the question, as and when required.

1. **(a)** Define simple random walk and Markov chain. Show that every simple random walk is a Markov chain. **2+3**

(b) Consider the Stochastic Process $\{X(t)\}$ defined by $X(t) = A\sin(2t + \theta)$, where A is a constant and θ is a uniform random variable over $(0, 2\pi)$. Examine whether $\{X(t)\}$ is a wide -sense stationary process or not. **5**

2. **(a)** State and prove Chapman Kolmogorov equation. **3**

(b) Consider the Markov chain with states 0, 1, 2 and transition probability matrix $\begin{pmatrix} \frac{1}{2} & \frac{1}{2} & 0 \\ 0 & 0 & 1 \\ \frac{2}{3} & 0 & \frac{1}{3} \end{pmatrix}$ **3+4**

(i) Examine the nature of the states (ii) Show that state 0 is nonnull recurrent.

3. **(a)** The transition probability matrix of a Markov chain $\{X_n\}$ with states 1, 2, 3 is as follows: $\begin{pmatrix} 0 & 1 & 0 \\ \frac{3}{5} & 0 & \frac{2}{5} \\ \frac{1}{5} & \frac{4}{5} & 0 \end{pmatrix}$ **3+3**

The initial distribution is $p^{(0)} = (\frac{4}{7}, \frac{2}{7}, \frac{1}{7})$.

Find (i) $P(X_2 = 3)$, (ii) Stationary distribution of the chain.

(b) Consider a Birth Death process where λ_i and μ_i are defined as follows: **2+2**

$\lambda_i = 10$, $i=0,1,2,3, \ldots$; $\mu_i = 40$, $i=1,2,3, \ldots$

Find (i) The stationary probability vector, (ii) The stationary probability for state 4.

4. **(a)** A gambler has Rs 3. At each play of the game, he loses Rs 1 with probability 2/5, but wins Rs 1 with probability 3/5. He stops playing if he lost his initial amount of Rs 3 or he wins at least Rs 2. Write down the tpm of the associated Markov chain. Find the probability that there are at least 3 rounds of the game. **5**

(b) A job shop consists of 3 machines and 2 repairmen. The amount of time that a machine works before breaking down is exponentially distributed with mean 7 hours. If the amount of time that it takes a single repairman to fix a machine is exponentially distributed with mean 5 hrs, formulate a birth and death process for the problem. **3+2**

(i) What is the average number of machines not in use?
(ii) What proportion of time are both repairmen busy?

PTO

5. (a) Arrivals at a telephone booth are considered to be Poisson with an average time of 10 minute between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 3 minute. **1+2+2**

(i) Find the average number of persons in the system and in the queue.

(ii) What is the probability that a person arriving at the booth will have to wait in the queue?

(iii) What is the probability that it will take for a person more than 15 minutes altogether to wait for the phone and complete his call.

(b) Find the mean, autocorrelation function and auto-covariance function of a Poisson process with rate λ. **1+2+2**

6. (a) Write short notes on the following terms with suitable example/diagram: **5+5**

i. Probability Distribution
ii. 'Standard error' in Sampling distribution
iii. Critical region
iv. Distribution function of a random variable
v. Normal Distribution

(b) The guaranteed average life of a certain type of electric bulbs is 1000 hrs with a SD of 125 hrs. It is decided to sample the output so as to ensure that 90% of the bulbs do not fall short of the guaranteed average by more than 2.5%. What must be the minimum size of the sample?

7. (a) Fit a Binomial Distribution to the following data. **5+5**

x	0	1	2	3	4
Frequency f(x)	28	62	46	10	4

(b) A random sample of 10 boys had the I.Q.'s: 70, 120, 110, 101, 88, 83, 95, 98, 107, 100. Do these data support the assumption of a population mean I.Q. as 100? At 5% LoS, find a reasonable range in which most of the mean I.Q.values of samples of 10 boys lie.

8. (a) a) In a year, there are 956 births in a town A of which 52.5% were males, while both in towns A and B combined, this proportion in a total of 1406 births was 0.496. Is there any significant difference in the proportion of male births in the two towns?. **5+5**

(b) 5 coins are tossed 3200 times and the number of heads appear in each test is noted. The test is as follows. Test the hypothesis that coins are unbiased.

No. of heads	0	1	2	3	4
Frequency	80	570	1100	900	500

9. (a) A random variable X has the density function **5+5**

$f(x) = 1/4 \; for -2 < x < 2, \; and \;\; 0 \;\; otherwise.$

Find the values of $(i)\, P(X<1), (ii)\, P(|X|>1), (iii)\, P(2X+3>5)$

(b) Two random samples were drawn from two normal populations and their values are

A	66	67	75	76	82	84	88	90	92	--	--
B	64	66	74	78	82	85	87	92	93	95	97

Test whether the two population have same variance at 5% level of significance.

****

Given Data:

- $\chi^2_{0.05} = 11.07$ at df 5
- $P(0 < z < 1.28) = 0.4$
- $F_{0.05} = 3.35$ at df (10, 8)
- $t_{0.05} = 1.833 \; for \; TTT \; at \; 9df$

National Institute of Technology, Silchar
Special- Examination, Feb. 2018

Subject Code: MA 1251
Semester: 4th
Duration: Three Hours

Subject: Introduction to Stochastic Process
Branch: CSE
Total Marks: 80

Figure in the right hand margin indicates full marks for the question.
Answer any eight questions

1. (a)	If $X(t) = \sin(2wt + Y)$, where Y is a uniform random variable over $(0, 2\pi)$ and w is a constant, examine whether $\{X(t)\}$ is a wide -sense stationary process or not.	3
(b)	Consider a Markov chain with three states 0, 1, 2 and transition probability matrix $P=\begin{pmatrix} 0 & \frac{2}{3} & \frac{1}{3} \\ \frac{1}{2} & 0 & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & 0 \end{pmatrix}$ Examine the nature of the states.	4
(c)	Consider a Birth Death process where λ_i and μ_i are defined as follows: $\lambda_i = 10$, $i=0,1,2,3, \ldots$ $\mu_i = 15$, $i=1,2,3, \ldots$ Find (a) The stationary probability vector, (b) The stationary probability for state 4.	2+1
2. (a)	When a state is said to be recurrent? If a state i is recurrent and state i communicates with state j, show that state j is also recurrent.	2+3
(b)	Find the autocorrelation function and auto-covariance function of a Poisson process with rate λ.	5
3. (a)	The initial state probability distribution of a Markov chain is $p(0)= (0.1, 0.4, 0.5)$ and the transition probability matrix $P=\begin{pmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ 0 & 1 & 0 \\ \frac{1}{8} & \frac{1}{2} & \frac{3}{8} \end{pmatrix}$ Find the stationary distribution of the chain.	3
(b)	Consider a Markov chain with transition probability matrix $P=\begin{pmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ 0 & 1 & 0 \\ \frac{1}{4} & \frac{1}{4} & \frac{1}{2} \end{pmatrix}$ Find (i) P^n (ii) $\lim_{n\to\infty} P^n$	2+5
4. (a)	Examine the ergodicity of the Markov chain with three states 0,1,2 and tpm $P=\begin{pmatrix} \frac{1}{3} & \frac{1}{3} & \frac{1}{3} \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{pmatrix}$.	6
(b)	A gambler has Rs 3. At each play of the game, he loses Rs 1 with probability 2/3 , but wins Rs 1 with probability 1/3. He stops playing if he lost his initial amount of Rs 3 or he wins at least Rs 2. Write down the tpm of the associated Markov chain. Find the probability that there are at least 3 rounds of the game.	4

5. (a)	Arrivals at a telephone booth are considered to be Poisson with an average time of 12 minute between one arrival and the next. The length of a phone call is assumed to be distributed exponentially with mean 4 minute. (i) Find the average number of persons in the system and in the queue. (ii) What is the probability that a person arriving at the booth will have to wait in the queue? (iii) What is the probability that it will take for a person more than 10 minutes altogether to wait for the phone and complete his call.	1+2+2
b)	A taxicab driver moves between the airport A and two hotels B and C according to the following rules: If he is at the airport, he will be at one of the two hotels next with equal probability. If at a hotel then he returns to the airport with probability ¾ and goes to the next hotel with probability ¼ . Suppose the driver begins at the airport at time 0. Find the probability that (i) he is at hotel B at time 2, (ii) He is at hotel A in the long run?	2+3
6. (a) (b)	Two digits are selected from the digits 1 to 9. If the sum is even, find the probability that both the numbers are odd. A and B alternatively throw a pair of dice. A wins if he throws a sum 'SIX' before B throws 'SEVEN' and B wins if he throws a sum 'SEVEN' before A throws 'SIX'. If A begins the throw, then find the probability of his winning.	4+6
7.	Two random samples have the following data: (see table below) Test whether they are from same normal population by verifying the equality of population variances and means. Given, $t_{0.05}$ $for\ 20\,df = 2.086$ & $F_{0.05}\ at\ df(9,11) = 2.9$	10
8.	In an examination, the candidates awarded the following grades. Distinction: $marks \geq 80\%$, 1^{st} Class: $60\% \leq marks < 80\%$, 2^{nd} Class: $45\% \leq marks < 60\%$, 3^{rd} Class: $30\% \leq marks < 45\%$, Fails: $<30\%$. If 8% of the students failed and 8% have distinction, find the percentage of students secured 2^{nd} division. Given, $\varphi^{-1}(0.42) = 1.405, P(0 < z < 0.56) = 0.2123, P(0 < z < 0.28) = 0.1103$	10
9.	Fit a Poisson Distribution to the following data and test the goodness of fit. Given, $\chi^2_{0.05}\ for\ 2df = 5.99$ (see table below)	10

Table for Q.7:

Sample	Size	Sample Mean	Sum of Squares of Deviation from Mean
1	10	15	90
2	12	14	108

Table for Q.9:

x	0	1	2	3	4	5	6
f(x)	275	72	30	7	5	2	1

****

National Institute of Technology Silchar
End-Semester (UG) Examination, May 2018

Subject Code: MA 1251, Subject: Introduction to Stochastic Process
Semester: 4^{th}, Department: CSE
Duration: Two Hours, Total Marks: 50

Figure in the right hand margin indicates full marks for the question

Answer any five questions.

The tabulated values which may be useful in solving the questions are given below. Use the appropriate one as and when required.

- $t_{0.05} = 1.833$ *for TTT at 9df*
- $P(0 < z < 1.28) = 0.4$
- $\chi^2_{0.05} = 11.07$ at $5\ df$

1. (a) Find variance and autocorrelation function of simple random walk. 2+2

(b) If $X(t) = A\cos t + B\sin t$ and $Y(t) = B\cos t - A\sin t$, where A and B are independent binary random variables, each of which assumes the values -1 and 3 with probabilities 3/4 and 1/4 respectively. Examine whether $\{X(t)\}$ and $\{Y(t)\}$ are jointly widen -sense stationary or not. 6

2. A man is at an integral point on the X-axis between the origin and point 3. If he is at 1 or 2, then he walks to the left or right with equal probability. If he reaches either at 0 or at 3, he stays there. Is there any absorbing states in this case? If yes, find the probabilities of absorption into those states. 4+6
Now, suppose that if the man reaches at 0, he turns around and returns to 1 on the next step and similarly, if he reaches 3 he returns on the next step to 2. What will be the new transition probability matrix? Is this new chain ergodic?

3. (a) The density function of the time to failure of an appliance is $f(t) = \frac{32}{(t+4)^3}$; t (>0) is in years. Find the reliability function and the MTTF. 2+2

(b) A system consists of 3 machines and 2 repairmen. At most 2 machines can operate at any time. The amount of time that an operating machine works before breaking down is exponentially distributed with mean 6 hours. The amount of time that it takes a single repairman to fix a machine is exponentially distributed with mean 5 hrs. Only one repairman can work on a failed machine at any given time. Let X(t) be the number of machines in operating at time t. 4+2
(a) Calculate the long run probability of X(t).
(c) What proportion of time are both repairmen busy?

4. (a) Show that in a finite state Markov chain not all states can be transient. 3

(b) A petrol pump station has 4 pumps. The service times follows the exponential distribution with a mean rate of 6 min and cars arrive for service in Poisson process at the rate of 30 cars per hour. Formulate a queueing model and hence answer the following questions: 4+3
(a) What is the probability that an arrival would have to wait in line?
(b) Find the average number of cars in the system.

PTO

5. (a) Write short notes on the following terms with suitable example/diagram: **5**

i. Types of errors
ii. 'Standard error' in Sampling distribution
iii. Critical region
iv. Distribution function of a random variable
v. Normal Distribution

(b) The guaranteed average life of a certain type of electric bulbs is 1000 hrs with a SD of 125 hrs. It is decided to sample the output so as to ensure that 90% of the bulbs do not fall short of the guaranteed average by more than 2.5%. What must be the minimum size of the sample? **5**

6. (a) Fit a Binomial Distribution to the following data. **5**

X	0	1	2	3	4
Frequency f(x)	28	62	46	10	4

(b) A random sample of 10 boys had the I.Q.'s: 70, 120, 110, 101, 88, 83, 95, 98, 107, 100. Do these data support the assumption of a population mean I.Q. as 100? At 5% LoS, find a reasonable range in which most of the mean I.Q. values of samples of 10 boys lie. **5**

****

National Institute of Technology, Silchar
Special (UG) Examination, July'2017

Subject Code : MA 1251, Subject: Introduction to Stochastic Process
Semester: 4th Branch: CSE
Duration: Three Hours. Total Marks: 80

Figure in the right hand margin indicates full marks for the question.
Answer any eight questions

The tabulated values which may be useful in solving the questions are given below. Use the appropriate one as and when required.

- $t_{0.05}$=1.345 at 13df for right tailed test
- $P(0 \le z \le 1.09) = 0.3621$
- $\chi^2_{0.05} = 11.07$ at df 5.

1. Explain the following terms with necessary diagram or example. **10**

i. χ^2 test
ii. Sampling error
iii. Fiducial Limit
iv. Degree of freedom
v. Critical value

2. A set of 5 coins are tossed 3200 times and the frequency against the number of heads appear in the test is noted as follows. **10**

No. of heads	0	1	2	3	4	5
Frequency	80	570	1100	900	500	50

Test the hypothesis that coins are unbiased.

3. Sample of two types of electric light bulbs were tested for length of life and following data were obtained. **10**

	1st Sample	2nd Sample
Sample Size	8	7
Sample Mean	1234 hrs	1036 hrs
Sample S.D.	36 hrs	40 hrs

Is the difference in the means sufficient to warrant that type I is superior to type II, in terms of length of life? Test at 5% LoS.

4. **(a)** Define simple random walk. Find mean, variance and autocorrelation function of simple random walk. **1+1+2+2**

(b) Consider the Stochastic Process {X(t)} defined by X(t) =1+ A sin(2t +θ) , where A is a constant and θ is a uniform random variable over (0, 2π). Examine whether { $X(t)$ } is a wide - sense stationary process or not. **4**

PTO

5. The initial state probability distribution of a Markov chain $\{X_n\}$ with states 1, 2, 3 is $p(0) = (0.2, 0.1, 0.7)$ and the transition probability matrix **3+2+2+3**

$$P = \begin{pmatrix} 0 & 1 & 0 \\ \frac{3}{5} & 0 & \frac{2}{5} \\ \frac{1}{5} & \frac{4}{5} & 0 \end{pmatrix}$$

(i) Examine the nature of states.

(ii) Find $P(X_2 = 2)$

(iii) Stationary distribution of the chain.

(iv) Is the state 1 recurrent?

6. **(a)** In a group of registered voters, 80% of those who voted in the last election will vote in the next election and 30% of those who didn't vote in the last election will vote in the next election. Find the transition probability matrix P of the associated Markov chain. Find P^n. In the long run, what percentage of the voters is expected to vote in a given election? **5**

(b) Prove that $p(n) = p(0)P^n$ **5**

7. **(a)** When a state is said to be transient? Show that in a finite state Markov chain not all states can be transient. **1+3**

(b) A gambler has Rs 3. At each play of the game, he loses Rs 1 with probability 3/5, but wins Rs 1 with probability 2/5. He stops playing if he lost his initial amount of Rs 3 or he wins at least Rs 2. Write down the tpm of the associated Markov chain. Find the probability that there are at least 4 rounds of the game. **6**

8. **(a)** Patients arrive at a doctor's chamber according to a Poisson process with a mean rate of $\frac{1}{5}$ per min. The doctor will not see a patient until at least 4 patients are in the waiting room. **2+2+2**

(i) Find the probability that during a time interval of 10 minutes at least 3 patients arrive.

(ii) Find the probability that time interval between two consecutive arrival is more than 6 minutes.

(iii) Find the expected waiting time until the first patient is admitted to see the doctor.

(b) Consider a Birth Death process where λ_i and μ_i are defined as follows: **4**

$\lambda_i = 10$, $i = 0,1,2,3, \ldots..$

$\mu_i = 20$, $i = 1,2,3, \ldots..$

Find (a) The stationary probability vector, (b) The stationary probability for state 4.

9. What do you mean by M/M/1/k queuing system? What are the differences between M/M/2/k and M/M/1 queuing systems? **3+1+2+1+3**

Customers arrive at a bank according to a Poisson process with an average time of 15 minute between one arrival and the next. The length of service is assumed to be distributed exponentially with mean 6 minute.

(i) What is the probability that a person arriving in the bank will have to wait in the queue?

(ii) What is the average time a customer spends in the queue? What is the probability that the waiting time in the system is greater than 10 minutes?

(iii) What is the probability that more than 5 customers are in the system?

(iv) If a customer arrives at 11 AM, at what time he can expect to finish his job and come out?

*****

National Institute of Technology, Silchar

End-Semester (UG) Examination, April'2017

Subject Code : MA 1251, | Subject: Introduction to Stochastic Process
Semester: 4th | Branch: CSE
Duration: Two Hours. | Total Marks: 50

Figure in the right hand margin indicates full marks for the question.

Answer any five question

1. (a) What do you mean by wide -sense stationary process? Explain with example. **2+5**
If $X(t) = \sin(wt + Y)$, where Y is a uniform random variable over $(0, 2\pi)$ and w is a constant, examine whether $\{ X(t) \}$ is a wide -sense stationary process or not.

(b) Consider a Markov chain with three states 0, 1, 2 and transition probability matrix **3**

$$P=\begin{pmatrix} \frac{1}{2} & \frac{1}{3} & \frac{1}{6} \\ \frac{3}{4} & 0 & \frac{1}{4} \\ 0 & 1 & 0 \end{pmatrix}$$

Find the period of the states.

2. (a) When a state is said to be recurrent? If a state i is recurrent and state i communicates with state j, show that state j is also recurrent. **2+3**

(b) The transition probability matrix of a Markov chain $\{X_n\}$ with states 0, 1, 2 is as follows: **3+2**

$$\begin{pmatrix} .2 & .4 & .4 \\ .5 & 0 & .5 \\ .3 & .6 & .1 \end{pmatrix}$$

The initial distribution is given as $p(0) = (0.6 , 0.3 , 0.1)$.

Find (i) $P (X_2 = 1)$, (ii) $P \{ X_3 = 1 , X_2 = 2, X_1 = 0, X_0 = 1 \}$.

3. Consider a Markov chain with three states 0, 1, 2 and transition probability matrix **4+2+1+3**

$$P=\begin{pmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ 0 & 1 & 0 \\ \frac{1}{4} & \frac{1}{4} & \frac{1}{2} \end{pmatrix}$$

Find (i) P^n (ii) $\lim_{n\to\infty} P^n$ (iii) Stationary distribution of the chain.

Also examine the nature of states using state transition diagram.

4. (a) Find the autocorrelation function and auto-covariance function of a Poisson process with rate λ. **5**

(b) Messages arrive at a telegraph office according to a Poisson process with a mean rate of 5 per min. Find the probability that **1.5+2+1.5**

(i) during a time interval of 7 minute at least 3 messages has arrived.
(ii) 1 hour has been elapsed since the last message has arrived.
(iii) time interval between two consecutive arrival of messages is more than 2 minutes.

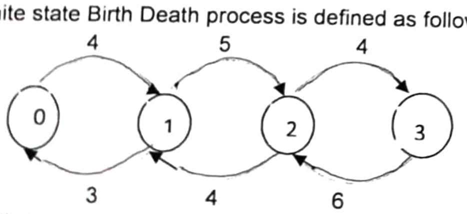
5. (a) When Ravi eats his evening meal he has iced tea, hot chocolate, iced coffee or water. He only has one beverage with his meal. He never has cold beverages twice in a row but if he has iced tea or iced coffee one time he is twice as likely to have hot chocolate as water the next time. If he has hot chocolate or water one evening he has a cold beverage the next time and is just as likely to choose iced tea as iced coffee. Set up the transition matrix for this Markov Chain. In the long run how often Ravi will have hot chocolate? **5**

b) People arrive to purchase cinema tickets according to a Poisson process with an average time of 12 minute between one arrival and the next. It takes an average of 10 minutes to purchase a ticket. **2+3**

(i) Find the average number of persons in the cinema hall and in the queue.
(ii) How much time can a person expect to spend before being seated for the start of the picture if it takes exactly 2 minutes to reach the correct seat after purchasing the ticket.

6. (a) Examine the ergodicity of the Markov chain with three states 0,1,2 and tpm $P=\begin{pmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ \frac{1}{2} & 0 & \frac{1}{2} \\ \frac{1}{4} & \frac{1}{4} & \frac{1}{2} \end{pmatrix}$. **6**

(b) A finite state Birth Death process is defined as follows: **4**



Find (i) the rate transition matrix, (ii) stationary probability vector,

****

MID-SEM EXAM., MAR.-2017, NIT SILCHAR
CLASS: B. Tech., BRANCH: CSE, SEMESTER: 4TH
Sub.: Introduction to Stochastic Process (MA 1251)

Full Marks: 30 **Time: 1hr.**

Answer ALL questions.

The tabulated values which may be useful in solving the questions are given below. Use the appropriate one as and when required.

- $t_{0.05}$=1.345 at 13df for right tailed test
- $P(0 \le z \le 1.09) = 0.3621$
- $t_{0.05}$=2.086 at df 20.
- $F_{0.05} = 3.35$ at df (10, 8)
- $\chi^2_{0.05} = 11.07$ at df 5

1. Write notes on each of the followings with necessary diagram or example. [5]
   i. Distribution Function
   ii. Fiducial Limit
   iii. Degree of freedom
   iv. Critical value
   v. Sampling error

2. 5 coins are tossed 3200 times and the frequency against the number of heads appear in the test is noted as follows. [5]

No. of heads	0	1	2	3	4	5
Frequency	80	570	1100	900	500	50

Test the hypothesis that coins are unbiased.

3. The marks X obtained in Mathematics by 1000 students is normally distributed with mean 78% and S.D. 11%. Determine (a) how many students got marks above 90% and (b) what is the highest mark obtained by the lowest 10% of students. [5]

4. In a year, there are 956 births in a town A of which 54.3% were males, while both in towns A and B combined, this proportion in a total of 1406 births was 0.496. Is there any significant difference in the proportion of male births in the two towns? [5]

5. The means of two single samples of 1000 and 2000 members are 67.5" and 68", respectively. Can the samples be regarded as drawn from the same population, which has the S.D. 2.5"? Test at 5% LoS. [5]

6. Sample of two types of electric light bulbs were tested for length of life and following data were obtained. [5]

	1st Sample	2nd Sample
Sample Size	8	7
Sample Mean	1234 hrs	1036 hrs
Sample S.D.	36 hrs	40 hrs

Is the difference in the means sufficient to warrant that type I is superior to type II, in terms of length of life? Test at 5% LoS.

---------------------X---------------------

National Institute of Technology, Silchar

End-Semester (UG) Examinations, May' 2017

Subject Code: CS-1205, Subject: Signals & Data Communication

Semester: 4th, Department: CSE

Duration: Two Hours, Total Marks: 50

Figure in the right hand margin indicates full marks for the question

Answer All Questions

1.	What is the advantage of using twisting in a cable and what is a guided transmission media and what is its guide?	2
2.	What are the advantages of use of high frequency as a carrier in passband communication?	2
3.	QAM is a combination of which two types of modulations and its advantages?	2
4.	Write the Shanon capacity of a noisy channel and what is the capacity of an extremely noisy channel?	2
5.	Write briefly about PCM?	3
6.	What is adaptive delta PCM and where is it used?	2
7.	What are the disadvantages of circuit switching and advantages of message switching?	3
8.	What are the functions of application layer of 7 layers OSI model?	2
9.	What limitations of a bridge are overcome by a router?	2
10.	What are the causes of transmission impairments and what are the impairments?	3
11.	What are the basic principles followed in layering of OSI model?	2
12.	Determine the CRC in both sender side and receiver side for the message 10010110 and polynomial 10011	3
13.	What are the advantages of using Dirac delta function in representing a signal?	2

***** P.T.O

14. An AM wave is represented by the expression: 4

$v = 5\,(1 + 0.6\cos 6280\,t)\sin 211 \times 10^4\,t$ volts

(i) What are the minimum and maximum amplitudes of the AM wave?

(ii) What frequency components are contained in the modulated wave and what is the amplitude of each component?

15. Consider the following table: 6

Code	Message	Probability
000	M1	0.3
001	M2	0.25
010	M3	0.15
011	M4	0.12
100	M5	0.10
101	M6	0.08

Calculate the efficiency of the above code and also find the Huffman coding for the above code?

16. Calculate the amount of information in the given string 'MALAYAM MADAM'? 3

17. What is the total delay (latency) for a frame of size 5 million bits that is being sent on a link with 10 routers each having a queuing time of 2 μs and a processing time of 1 μs. The length of the link is 2000 Km. The speed of light inside the link is 2×10^8 m/s. The link has a bandwidth of 5 Mbps. Which component of the total delay is dominant? Which one is negligible? 4

18. Sketch the following encoding schemes for the data 10101101100010

(i)NRZ-I 3

NATIONAL INSTITUTE OF TECHNOLOGY, SILCHAR
COMPUTER SCIENCE AND ENGINEERING DEPARTMENT
B. Tech. 4th Sem., Mid Term Examination, Feb. 2017
Subject: Signals and Data Communication (CS- 1205)
Time: **One hour**
Total Marks: **30**

Answer all the questions:

1. Mention how continuous, discrete and digital signals are related? 2
2. What is convergence in FS? 2
3. What is the importance of impulse function in the expression of any function? 2
4. Relate and contrast between LT and ZT. 2
5. How is the stability of a causal system determined in DTS? 2
6. (a) What is the importance of convolution and when do we use it? 3
   b) What are complementary functions in the solution of differential equation and why are they called complementary? 2
7. The first-order difference equation $y[n] - a\,y[n-1] = x[n]$, $0 < a < 1$, describes a particular discrete-time system initially at rest. Is the system 2
   i) Memory less. ii) Causal. iii) Stable. Clearly state your reasoning.
8. Consider the signal 2
   $$x(t) = \begin{cases} 2\cos(4t) & t > 0 \\ 0 & \text{otherwise} \end{cases}$$
   Find its even and odd decompositions.
9. Find the energy and power of the complex signal 3
   $$y(t) = \begin{cases} (1+j)e^{j\pi t/2}, & \text{for } 0 \le t \le 10 \\ \text{zero, otherwise} \end{cases}$$
10. Find the Z-transform of: 2
    $$x(k) = \begin{cases} \sin(\omega kT) & k \ge 0 \\ 0 & k < 0 \end{cases}$$
11. Check whether the following system is an LTI system, also provide the reasons 2
    $$Y(t) = x(t)\cos\omega_c(t)$$
12. Find the inverse Z-transform of the following function: 4
    $$\frac{Z^2+Z}{Z^2-3Z+4}$$

National Institute of Technology Silchar

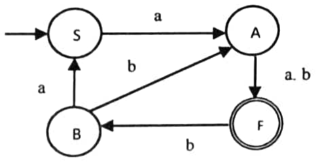
End-Semester (UG) Examination, May, 2017

Subject code: CS-1204,
Semester: 4th
Duration: Two Hours

Subject: Formal Languages and Automata Theory
Branch: Computer Science & Engineering
Total Marks: 50

Figure in the right hand margin indicates full marks for the question.

1. [a] Write the basic strategies for the removal of null string. [b] Design a FA over alphabet {0, 1}, which accepts the set of strings either start with 01 or end with 01. [c] Find the regular expression corresponding to the following finite automaton using Arden's theorem.



(2+4+4)

2. [a] Use pumping lemma to prove that the language $L = \{0^p \mid p\ is\ a\ prime\ number\}$ is not regular. [b] Describe the procedure with an example to find $L = L_1 - L_2$. [c] Write the algorithm to find the regular expression corresponding to a finite automaton. [d] Prove that Arden's theorem has unique solution.

(2+3+2+3)

3. [a] Suppose M is a finite automata, how can you prove that L(M) is infinite? [b] How can ambiguity be removed from CFG? [c] Show that the grammar $S \rightarrow a/abSb/aAb \quad A \rightarrow bS/aAAb$ is ambiguous. [d] What are the probable problems in a defective grammar?

(2+2+4+2)

4 [a] Let $L = \{a^m b^n \mid n < m\}$. Write a CFG for L. [b] Write the pumping lemma for context free grammars. [c] Consider the following grammar and remove $\in -production$, $S \rightarrow aSa \quad S \rightarrow bSb/\in$. [d] Write the name of non-closure properties of CFG. [e] Write the procedure to remove non-terminals which fail to generate terminals in CFG.

(2+2+2+1+3)

5 [a] The production system of a CFG G(V= {S, X, Y}, Σ= {0, 1}, P, S) is $S \rightarrow XY \quad X \rightarrow YS|1 \quad Y \rightarrow SX|0$. Create an equivalent CFG $G_1(V_1, \{0, 1\}, P_1, S)$ in GNF. [b] Design a PDA for language, $L = \{a^n b^m a^n \mid m, n \geq 1\}$.

(5+5)

National Institute of Technology, Silchar

Mid-Semester (UG) Examination, March' 2017

Subject code: CS-1204, Subject: Formal Languages and Automata Theory

Semester: 4th, Branch: Computer Science & Engineering

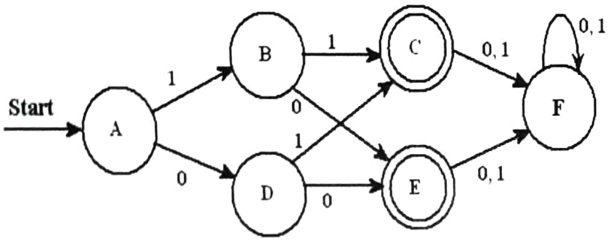
Duration: One Hour, Total Marks: 30

Figure in the right hand margin indicates full marks for the question.

1. [i] Define string with example. [ii] What is the necessity of phrase structure grammars in automata theory? [iii] Describe Chomsky classification of languages with example. [iv] Define transition table. [v] How does Mealy machine differ from Moore machine? Explain.

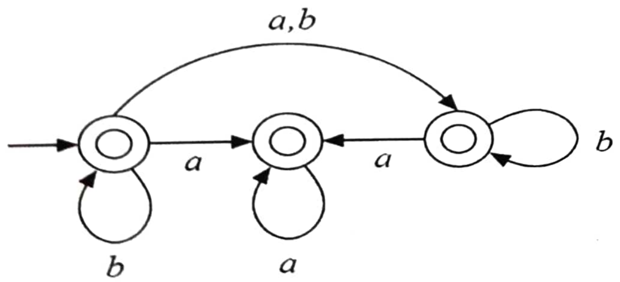
(1+2+3+2+2)

2. [i] How can you say that two finite automata M_1 and M_2 are equivalent? [ii] Find regular expression and construct the DFA for the set of all strings consisting of even numbers of 11 over {0, 1}. [iii] Minimize the states of the following DFA



(2+4+4)

3. [i] Construct a ϵ -NFA equivalent to the regular expression $(((aa + bb + \epsilon)(ab + ba)^* + a)^* + b)$. [ii] Prove that $((1^*0+001)^*01)$ and $(1^*001 + 00101)^*$ are equivalent. [iii] Show that regular languages are closed under intersection. [iv] What is the shortest string *not* accepted by the following NFA?



4th/CSE/2016/BTech

National Institute of Technology, Silchar

Winter term (UG) Special Examination, December-2016

Subject Code: MA 1251, Subject: Introduction to Stochastic Process

Semester: 4th Branch: CSE

Duration: Three Hours, Total Marks: 80

Figure in the right hand margin indicates full marks for the question.

1. Explain with example: (a) Wide sense stationary process (WSSP) (b) Strictly stationary process. Consider the Stochastic Process $\{X(t)\}$ defined by $X(t) = A\cos(wt + Y)$, where A and w are constants and Y is uniform random variable over $(0, 2\pi)$. Show that $\{X(t)\}$ is a WSSP. 4+4

2. If state i is recurrent *and* $i \leftrightarrow j$, prove that state j is also recurrent. 5

3. Prove that $p(n) = p(0)P^n$ 5

4. Find mean, variance and auto correlation function of a simple random walk. 1+2+3

5. Patients arrive at a doctor's chamber according to a Poisson process with a mean rate of 2 per min. Find the probability that 2+3
   (i) during a time interval of 10 minute no patient has arrived.
   (ii) time interval between two consecutive arrival is more than 5 minutes.

6. The transition probability matrix of a Markov chain $\{X_n\}$ with states 0, 1, 2 is as follows: 3+4

$$\begin{pmatrix} .2 & .4 & .4 \\ .5 & 0 & .5 \\ .3 & .6 & .1 \end{pmatrix}$$

   The initial distribution is $p^{(0)} = (.6, .3, .1)$. Find (i) $P(X_2 = 1)$, (ii) $P\{X_3 = 1, X_2 = 2, X_1 = 0, X_0 = 1\}$.

7. Find P^n for the transition probability matrix $P = \begin{pmatrix} \frac{1}{2} & \frac{1}{4} & \frac{1}{4} \\ 0 & 1 & 0 \\ \frac{1}{4} & \frac{1}{4} & \frac{1}{2} \end{pmatrix}$ 5+2

   Also find (i) $\lim_{n\to\infty} P^n$ (ii) Stationary distribution of the chain.

8. Consider a Birth Death process where λ_i and μ_i are defined as follows: 4+3

   $\lambda_i = 20$, i=0,1,2,3, ...; $\mu_i = 25$, i=1,2,3, ...

   Find (a) The stationary probability vector, (b) The stationary probability for state 3.

9. Find the standard deviation and Karl Pearson's coefficient of Skewness for following distribution. 10

Variable	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40
Frequency	2	5	7	13	21	16	8	3

10. In a certain college 25% of boys and 10% of girls are studying Mathematics. The girls constitute 60% of the student body. 10
    a) What is the probability that Mathematics is being studied?
    b) If a student is selected at random and is found to be studying Mathematics, find the probability that the student is (i) a girl? (ii) a boy?

11 Derive the regression line 'of X on Y'. Obtain the value of Y (correct up to 2 decimal places) when X=6.2 by fitting a regression line for the following data. 10

X:	1	2	3	4	5	6	7	8	9
Y:	9	8	10	12	11	13	14	16	15