L-2/T-2/CSE **Date : 01/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **CSE 207** (Algorithms)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Write down two algorithms for recognizing a leap year. Deduce their complexities. **(5+5)**

   (b) Write down two versions of Binary search algorithm. Deduce average case complexity of both of them. **(5+5)**

   (c) If an element appearing later in an array is smaller than one element appearing earlier then this is called an inversion. So in the array 2 5 3 1 there are (1 + 2 + 1 + 0 =4 inversions). Given an array A of integers using the idea of mergesort construct an *O(nlogn)* algorithm for determining number of inversions. **(15)**

2. (a) Write down two algorithms for constructing a max heap and deduce their complexities. Discuss how Carlsson reduces the leading coefficient in the complexity of the heapsort algorithm. **(10)**

   (b) Write down a linear time algorithm for finding maximum sum of a consecutive subsequence of an array. **(15)**

   (c) Write down traditional algorithms for finding minimum and maximum of an array, and a recursive algorithm. Compare their complexities. **(10)**

3. (a) Write down the pseudo code of Quicksort algorithm including partition. Deduce its average case complexity. Simulate partition algorithm on the array 6, 2, 7, 3, 8, 4, 9, 5, 10, 1, 11 using the first element as the partitioning element. Show whenever elements are swapped. **(10)**

   (b) Given a directed graph with edge list and weight AB(5), BC(2), AC(4), AD(6), CD(3), DB(1), DE(6), EB(3), EF(3), FB(4) construct a mincost arborescence rooted at A. (edge CD(3) means edge is directed from C to D and has weight 3). **(10)**

   (c) Find a minimum spanning tree using both Kruskal's algorithm and Prim's algorithm starting from A in the underlying graph of Question 3(b) with edge weights mentioned in parentheses. **(15)**

14

Contd P/2

CSE 207

4. (a) Given a set of jobs with start and finish times write down an algorithm so that maximum number of jobs can be processed. Show counterexamples for some natural greedy algorithm that will not find optimal solutions. **(10)**

   (b) Solve the Multi_Peg Tower of Hanoi problem with (n,p)=(377,8). Find kmax, Na and n_l for at least two subproblems. **(10)**

   (c) Given the message 'abaacbdbebfbcdcecf' construct a dynamic Huffman frees showing how trees are updated after sending each symbol and code of the symbol. **(15)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Write a linear-time algorithm and an exponential-time algorithm for finding the nth Fibonacci number. Analyze the time-complexity of each algorithm. **(10)**

   (b) Write a parallel algorithm for computing the sum of n numbers. Also, write a parallel algorithm to multiply two $n \times n$ matrices that runs in $O(\log n)$ time. **(10)**

   (c) Using dynamic programming compute the minimum number of scalar multiplications for the matrix chain multiplication of A_1, A_2, A_3, A_4, A_5, A_6 with dimensions 15×5, 5×50, 50×20, 20×10, 10×35, 35×25, respectively. Also, show the ordering of the matrices for the desired minimum number of scalar multiplications. **(15)**

6. (a) Compare dynamic programming and memorization techniques. **(10)**

   "A dynamic programming algorithm usually outperforms the corresponding memorized algorithm" – explain.

   (b) Write a memorized algorithm for solving the matrix chain multiplication problem. Analyze the time-complexity of the algorithm. **(10)**

   (c) What is a state-space tree? **(15)**

   Solve the following instance of the 0/1 knapsack problem using the branch-and-bound approach with a state-space tree. Assume that the knapsack capacity is 10.

Item	Weight	Value
1	7	42
2	4	40
3	3	12
4	5	25

7. (a) Write and prove the max-flow min-cut theorem. Explain how one can convert a multiple-source, multiple-sink maximum-flow problem into a problem with a single source and a single sink. **(10)**

   (b) Prove that the longest common subsequence problem has both the Overlapping Subproblems property and the Optimal Substructure property. **(10)**

Contd P/3

CSE 207
Contd ... Q. No. 7

(c) Find all longest common subsequences of $X = \langle \textbf{ATGCTGAT} \rangle$ and $Y = \langle \textbf{TGGCATA} \rangle$ using dynamic programming method. **(15)**

8. (a) Write the names of four NP-complete problems. Define the following six classes of problems: P, Co-P, NP, Co-NP, NP- complete and NP-hard. By a diagram show the relationship among these classes of problems that most researchers regard as the most likely. **(10)**

(b) If L_1 and L_2 are two languages such that $L_1 \leq_p L_2$, then show that $L_2 \in$ P implies $L_1 \in$ P. If an NP-complete problem is polynomial solvable, then prove that P = NP. **(10)**

(c) Write a polynomial-time 2-approximation algorithm for the traveling-salesman problem where the edge weights satisfy the triangle inequality, and prove the approximation ratio of the algorithm.

If P $\neq$ NP, then prove that for any constant $\rho \geq 1$, there is no polynomial-time approximation algorithm with ratio ρ for the general traveling-salesman problem. **(15)**

L-2/T-2/CSE **Date : 08/07/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 BURP Examinations 2013-2014

Sub : **CSE 209** (Digital Electronics and Pulse Techniques)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Draw the circuit for one stage of a two-phase dynamic MOS shift register and explain its operation. **(12)**

   (b) (i) What does the acronym FAMOS mean? **(1+5+5=11)**

   (ii) How is such a cell "programmed"?

   (iii) How is the cell erased?

   (c) (i) Draw a 1-MOSFET dynamic memory cell and explain its operation briefly.

   (ii) Explain how data of such a cell will be destroyed during read operation. **(6+6=12)**

2. (a) Draw the circuit diagram of a 2-input CMOS NOR gate and explain its operation. **(12)**

   (b) Why are MOS logic gates slower than BJT logic gates? **(12)**

   (c) Can a TTL logic gate drive a CMOS logic gate directly? Justify your answer. **(11)**

3. (a) Draw the circuit diagram of a 2-input OR/NOR ECL logic gate and explain its operation. **(18)**

   (b) In DTL, TTL and MOS/CMOS logic circuits negative end of the power supply is grounded, whereas in ECL positive end of the power supply is grounded. Explain, with calculations, from the view point of noise effect why this is done. **(17)**

4. (a) Draw the circuit diagram of a 2-input TTL NAND gate with tri-state output. Explain how tri-state output works. **(12)**

   (b) What is an "open collector" output of a TTL logic gate? What advantages can we get from such a gate? **(5+5=10)**

   (c) (i) Draw the circuit diagram of a 2-input DL OR gate for positive logic. **(5+8=13)**

   (ii) Explain how the same circuit will work as an AND gate for negative logic.

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. In a robot development laboratory, you are given a job of an audio specialist. The laboratory develops two different types of robots- bird robot and dog robot.

Contd P/2

CSE 209

Contd ... Q. No. 5

The bird robot needs to produce high frequency audio sound and the dog robot needs to produce low frequency audio sound. For being the audio specialist, you need to design filter components required in the audio systems of both the robots. To do so, you need to answer the following: **(10+15+10)**

(a) Design the two different filters.

(b) Calculate amplification or gain of both the filters for sinusoidal wave input.

(c) Draw output waveforms generated in case of inputting very-low-frequency square wave in the bird robot's filter and very-high-frequency square wave in the dog robot's filter. Consider the square wave to be symmetric having a peak-to-peak voltage of V, time period of T, and d-c voltage level of V_{avg}.

6. In a speed monitoring system for ocean current, a transducer is used to convert the speed of current to a proportional voltage level. After devising the system, the manufacturer company deploys it in real ocean. In real settings, the system starts facing a problem of experiencing high voltage in case of transient very-high-speed current. Such transient very-high-speed current results in a high voltage level leading towards damage of the device.

   Now, you are given the job of solving the problem. Here you need to design a component such that very high voltage levels (both positive and negative that may arise for two opposing directions of current) get clipped off while passing through the component. You need to design the component in two different ways: **(17½+17½)**

   (a) Both upper and low voltage thresholds can be controlled independently.

   (b) Only the upper voltage threshold can be controlled independently.

   Draw circuits and transfer characteristics of both the components with corresponding working mechanics.

7. (a) Draw and describe transfer characteristics of a practically used Schmitt trigger. **(17)**

   (b) In a typical negative clamper consisting of a capacitor and a diode connected in series, what will happen if the amplitude of sinusoidal input wave suddenly increases or suddenly decreases? **(18)**

8. (a) Design a 4-bit DAC using only two types of resistances. Briefly present operation of one bit input in your design. **(15)**

   (b Write short notes on the following: **(10+10)**

   (i) Astable multi-vibrator, (ii) Dual-slope ADC

L-2/T-2/CSE **Date : 02/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **MATH 243** (Matrices, Vectors, Fourier Analysis and Laplace Transforms)

Full Marks : 280 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Find the adjoint of the matrix $A = \begin{bmatrix} 3 & 2 & -1 \\ 1 & 6 & 3 \\ 2 & -4 & 0 \end{bmatrix}$ and hence find A^{-1}. Also, verify that $AA^{-1} = I_3$. **(16⅔)**

(b) Solve the following system of linear equations by reducing the augmented matrix into its reduced row-echelon form:

$$x + y + 2z = 9$$
$$2x + 4y - 3z = -1$$
$$3x + 6y - 5z = -3$$

Write down the above system in matrix form $AX = B$, then find A^{-1} by elementary row operations and then find X using A^{-1}. **(30)**

2. (a) State Cayley-Hamilton theorem and verify this theorem for the matrix

$$A = \begin{bmatrix} 2 & 7 & 0 \\ 4 & 5 & 1 \\ 3 & 2 & 1 \end{bmatrix}.$$

Hence find the inverse of A using this theorem. **(16⅔)**

(b) Find the eigen values and the corresponding eigen vectors of the matrix

$$A = \begin{bmatrix} 5 & -1 & 1 \\ -1 & 2 & -4 \\ 1 & -4 & 2 \end{bmatrix}.$$

Find the matrix S that diagonalizes A and hence determine the corresponding diagonal matrix of A. **(30)**

3. (a) Find a subset of vectors $\underline{u_1} = (1, -2, 0, 3)$, $\underline{u_2} = (2, -5, -3, 6)$, $\underline{u_3} = (-4, 11, 9, -12)$, $\underline{u_4} = (2, -1, 4, -7)$ and $\underline{u_5} = (5, -3, 11, -11)$ that forms a basis for the space spanned by these vectors. Also, express each vector not in the basis as a linear combination of the basis vectors. **(16⅔)**

Contd P/2

(b) Let $T: P_2 \rightarrow P_2$ be the linear operator defined by $T(p(x)) = xp\ (x - 3)$. Find the matrix for T with respect to the standard bases $B = \{1, x, x^2\}$ and $B' = \{1, x, x^2, x^3\}$. Also, for any $\underline{x} \in P_2$, verify the relation $A[\underline{x}]_B = [T(\underline{x})]_{B'}$, where A is the matrix for T with respect to the bases B and B'. **(15)**

(c) Consider the basis $S = \{\underline{u}, \underline{v}, \underline{w}\}$ for R^3, where $\underline{u} = (1, 2, 1)$, $\underline{v} = (2, 9, 0)$, and $\underline{w} = (3, 3, 4)$ and let $T: R^3 \rightarrow R^2$ be the linear transformation such that $T(\underline{u}) = (1, 0)$, $T(\underline{v}) = (-1, 1)$ and $T(\underline{w}) = (0, 1)$,. Find a formula for $T(x, y, z)$ and use this formula to find $T = (7, 13, 7)$.

4. (a) Consider the set P_2 of all polynomials of degree 2 and the set $S = \{p_1, p_2, p_3\}$ where $p_1 = 1 + x$, $p_2 = 1 + x^2$, $p_3 = x + x^2$. Is the set S a basis for P_2? If so, find the coordinate vector of the polynomial $p(x) = 2 - x + x^2$ relative to the basis S. **(16)**

(b) Define linearly dependent and independent set of vectors. Examine whether the vectors $\underline{u} = (1, -3, 2)$ $\underline{v} = (2, -4, -1)$ and $\underline{w} = (3, 2, -1)$ are linearly dependent or independent. Express $(1, -12, 4)$ as a linear combination of $\underline{u}$, $\underline{v}$ and $\underline{w}$ **(18)**

(c) Prove that the volume of the parallelopiped whose adjacent edges are $\underline{a} \times \underline{b}$, $\underline{b} \times \underline{c}$, and $\underline{c} \times \underline{a}$ is equal to the square of the volume of the parallelopiped whose adjacent edges are $\underline{a}$, $\underline{b}$, $\underline{c}$. **($12\frac{2}{3}$)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Given the vector field $\vec{G} = (16xy - z)\hat{i} + 8x^2\hat{j} - x\hat{k}$

(i) Is $\vec{G}$ irrotational (or conservative)?

(ii) Find the net flux of $\vec{G}$ over the cube $0 < x, y, z < 1$.

(iii) Determine the circulation of $\vec{G}$ around the edge of the square $z = 0$, $0 < x, y < 1$. Assume anticlockwise direction. **($30\frac{2}{3}$)**

(b) Consider the vector field given by $\vec{F} = (x - z)\hat{i} + (y - x)\hat{j} + (z - xy)\hat{k}$. Use Stokes' Theorem to find the circulation around the triangle with vertices $A(1, 0, 0)$, $B(0, 2, 0)$, and $C(0, 0, 1)$ oriented counterclockwise looking from the origin toward the first octant. **(16)**

6. (a) By using the definition of error function $erf(t) = \frac{1}{\sqrt{\pi}}\int_0^t e^{-u^2}du$, prove that $L\{erf\sqrt{t}\} = \frac{1}{s\sqrt{s+1}}$. Hence show that $L\{erfc\sqrt{t}\} = \frac{1}{\sqrt{s+1}\left(\sqrt{s+1}+1\right)}$, where $erfc(t)$ is called complementary error function. **($22\frac{2}{3}$)**

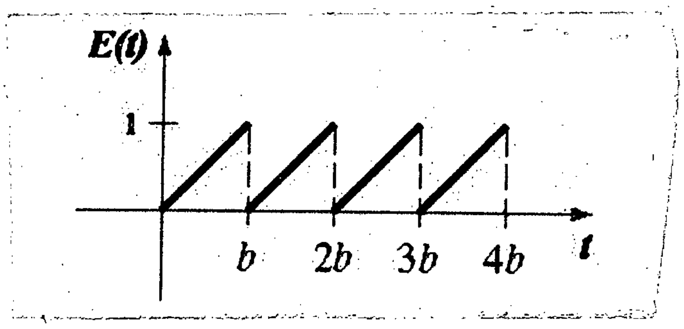
MATH 243(CSE)
Contd ... Q. No. 6

(b) Using Heaviside's expansion formula find $L^{-1}\left\{\frac{s+5}{\sqrt{(s+1)(s^2+1)}}\right\}$. **(12)**

(c) Using the convolution theorem, verify that

$$\int_0^t sin(u)cos(t-u)du = \frac{1}{2}t\,sint$$ **(12)**

7. (a) Solve the differential equation $L\frac{di}{dt}+Ri(t)=E(t)$ subject to $i(0)=0$ where $L=1$, $R=1$ and $E(t)$ is given by the following saw tooth function with amplitude 1 and $b=1$. (Using Laplace transform) **(24⅔)**



(b) Using Laplace transform solve the given system of differential equations

$$2x'(t)+y'(t)-2x(t)=1$$
$$x'(t)+y'(t)-3x(t)-3y(t)=2$$

subject to $x(0)=y(0)=0$ **(22)**

8. (a) If $-\pi \le x \le \pi$ and $p \ne 0, \pm 1, \pm 2, \cdots\cdots$, then find Fourier series of $cos(px)$.

Hence deduce, $sin\,x = x\left(1-\frac{x^2}{\pi^2}\right)\left(1-\frac{x^2}{4\pi^2}\right)\left(1-\frac{x^2}{9\pi^2}\right)\cdots\cdots$ **(12)**

(b) Expand $f(x)=\begin{cases} x, & 0\le x<4 \\ 8-x, & 4\le x\le 8 \end{cases}$ in half range sine and cosine series. Also show the graphical difference of the function for both series. **(12)**

(c) Solve the boundary-value problem using suitable Fourier transform

$$\frac{\partial U}{\partial t}=\frac{\partial^2 U}{\partial x^2} \qquad 0<x<6, \quad t>0$$
$$U_x(0,t)=0, \quad U_x(6,t)=0, \quad U(x,0)=2x$$

Give a physical interpretation of the above problem. **(22⅔)**

L-2/T-2/CSE **Date : 06/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **CSE 211** (Theory of Computation)

Full Marks : 140 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Convert the following context free grammar into an equivalent pushdown automation: (7)

$$E \to E + T \mid T$$
$$T \to T \times F \mid T/F \mid F$$
$$F \to (E) \mid a$$

(b) Construct the state diagram of a pushdown automation that recognizes the following language $L = \{a^i b^j c^k : i = j \text{ or } j = k \text{ where } i, j, k \geq 0\}$. **(7)**

(c) Prove that for any pushdown automation P, there exists a context free grammar G such that $L(P) = L(G)$. **($9\frac{1}{3}$)**

2. (a) Build a Turning machine to recognize the language $L = \{0^N 1^N 0^N \mid N \geq 0\}$. **(7)**

(b) How can we recognize the left end of the tape of a Turing machine? Explain. **(7)**

(c) Use the pumping lemma to show that the following language are not context free: **($9\frac{1}{3}$)**

(i) $L = \{0^n 1^n 0^n 1^n \mid n \geq 0\}$.

(ii) $L = \{0^n \#0^{2n} \#0^{3n} \mid n \geq 0\}$.

3. (a) Answer the following questions, and explain your reasoning: **(7)**

(i) Can a Turing machine ever write the blank symbol on its tape?

(ii) Can the tape alphabet Γ be the same as the input alphabet Σ?

(iii) Can a Turing machine's head ever be in the same location in two successive steps?

(iv) Can a Turing machine contain just a single state?

(b) Let A be the language containing only the single string s, where

$$s = \begin{cases} 0 \text{ if life never will be found on Mars} \\ 1 \text{ if life will be found on Mars someday} \end{cases}$$

Is A decidable? Why or why not? For the purposes of this problem, assume that the question of whether life will be found on Mars has an unambiguous YES or NO answer. **(7)**

(c) Show that every nondeterministic Tuning machine has an equivalent deterministic Tuning machine. **($9\frac{1}{3}$)**

Contd P/2

CSE 211

4. (a) Consider the language A_{DFA} = {<B, w> | B is a DFA accepting w }. Prove that A_{DFA} is decidable. **(7)**

(b) Prove that the set of rational numbers is countable. **(7)**

(c) Prove that A_{TM} = {<M, w> | M is a Turing machine accepting w}. is not decidable. **($9\frac{1}{3}$)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) Prove that regular languages are closed under minus (–) operation where minus (–) operation is defined as $L_1 - L_2 = \{w \mid w \in L_1 \text{ but } w \notin L_2\}$. **(8)**

(b) Show a counter-example to disprove the following statement: If R_1 and R_2 are two regular expressions, then $(R_1 \cup R_2)^* = R^*_1 \cup R^*_2$.

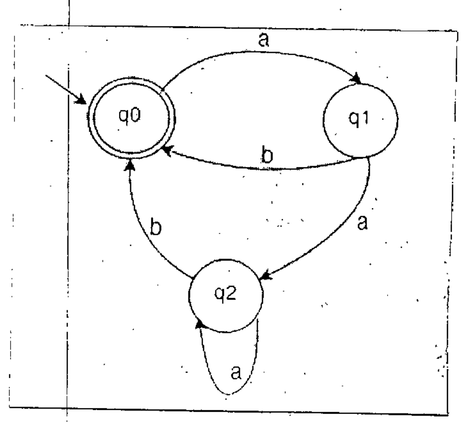
(c) Construct a DFA to recognize the following language L: **($10\frac{1}{3}$)**

$L = \{w \in \{a, b\}^* \mid w = a^p b^q,\ p + q \text{ is even}\}$.

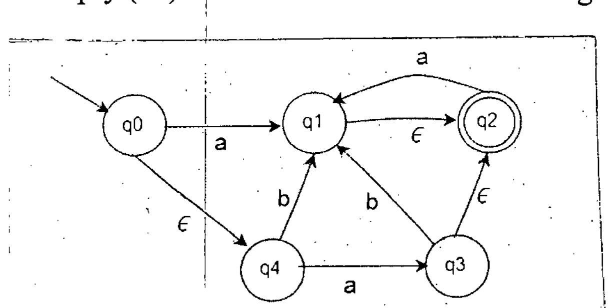
6. (a) State and prove the Pumping lemma for regular languages. **($7\frac{1}{3}$)**

(b) Let Σ = {(,)} and let L be the language consisting of all strings of properly nested parenthesis. For example L contains "( ) ( )", "((( )))", "(( )( ) ((( )( )))", and ϵ, but not ")(" and "((((". Using Pumping lemma show that L is not regular. **(8)**

(c) Construct a regular expression from the following NFA: **(8)**



7. (a) Eliminate all empty (ϵ) – transitions from the following NFA: **(9)**



Contd P/3

CSE 211
Contd ... Q. No. 7

(b) Construct a context free grammar to recognize the following language L: **($8\frac{1}{3}$)**

$L = \{w \in \{a,b,c\}^* \mid w = a^i b^j, c^k, i \geq 0, j \geq 0, k \geq 0\}$.

Draw a parse tree for the string ab^2c^3 according to your grammar.

(c) Show that the following language L is not context free: **(6)**

$L = \{w \in \{a,b,c\}^* \mid w = a^n b^{2n}, c^{3n}, n \geq 0\}$.

8. (a) Suppose L_1 and L_2 are two regular languages. Let $M_1 =< \Sigma, Q_1, q_0^2, \delta_1, F_1 >$ and $M_2 =< \Sigma, Q_2, q_0^2, \delta_2, F_2 >$ be two DFAs that recognize L_1 and L_2 respectively. Describe the steps to construct a DDA that recognize the language $L_1 \cup L_2$. **(7)**

(b) Prove that every NFA has an equivalent DFA. **($10\frac{1}{3}$)**

(c) Show a counter-example to disprove the following statement: Every subset of a regular language is also regular. **(6)**

L-2/T-2/CSE **Date : 10/08/2015**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **EEE 269** (Electrical Drives and Instrumentation)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION71-73

SECTION – A

There are **FOUR** questions in this Section. Answer any **THREE**.

If you think that any problem has missing data, make a reasonable assumption and state it in your solution.

1. (a) Distinguish between exact and approximate equivalent circuits of a single phase transformer. Write about the influence of leakage flux on the operation of a transformer. **(15)**

   (b) The secondary winding of a single phase transformer has a terminal voltage which can be expressed as time domain function as $v_s(t) = 282.8 \sin(377\,t)$ V. The turns ratio of the transformer is 50 : 200. The secondary current for the transformer can be expressed as $i_s(t) = 7.07 \sin(377t - 36.87°)$. The impedances of this transformer, referred to the primary side are given as **(20)**

   $$R_{eq} = 0.05\ \Omega \quad R_c = 75\ \Omega$$
   $$X_{eq} = 0.225\ \Omega \quad X_m = 20\ \Omega$$

   (i) Draw the equivalent circuit for the transformer.

   (ii) What is the primary current of this transformer?

   (iii) Determine the transformer's efficiency.

2. (a) Explain the concept of counter emf for a dc motor. With mathematical proof, show how counter emf can control the motor's efficiency. How can you prove the existence of counter emf in a laboratory environment? **(17)**

   (b) Assume for a dc shunt motor the armature resistance is set at $r_a = 0.5\ \Omega$ and the field resistance is set at $R_f = 220\ \Omega$. Under these conditions, it runs at 1000 rpm drawing 20 A from a 220 V supply. Now, the field resistance is increased by 5%. Under the new conditions, **(18)**

   (i) calculate the new steady state armature current.

   (ii) Calculate the new motor speed. Assume the load torque to be constant for the motor.

3. (a) For a balanced three phase system, the relationship between line current and phase current in one of the phases may be expressed as $I_a = I_{AB}\ \sqrt{3}\ \angle -30°$, where the symbols have their usual meanings. Identify the system(s) and mathematically prove the mentioned relationship for all the phases.

Contd P/2

EEE 269
Contd ... Q. No. 3

(b) A balanced three-phase source supplies power to three loads. The ratings of the loads are:

Load 1: 18 kW at 0.8 pf lagging.

Load 2: 10 kW at 0.6 pf leading.

Load 3: unknown.

If the line voltage at the load is 208 V rms, the magnitude of the total complex power is 41.93 kVA and the combined power factor at the load is 0.86 lagging, find the rating of the unknown load. **(18)**

4. (a) Explain the reasons behind the employment of a three phase system in a power network. Mention the differences between single phase and three phase transformers. **(15)**

(b) For the three phase network shown below, find the line currents as indicated in the figure. Also, calculate the power delivered to the line and the load components. Here, assume $V_{ab} = 440 \angle 10°$, $V_{bc} = 440 \angle 250°$, and $V_{ac} = 440 \angle 130°$. Identify the system's phase sequence and distinguish between different ac power components in your answers. **(20)**

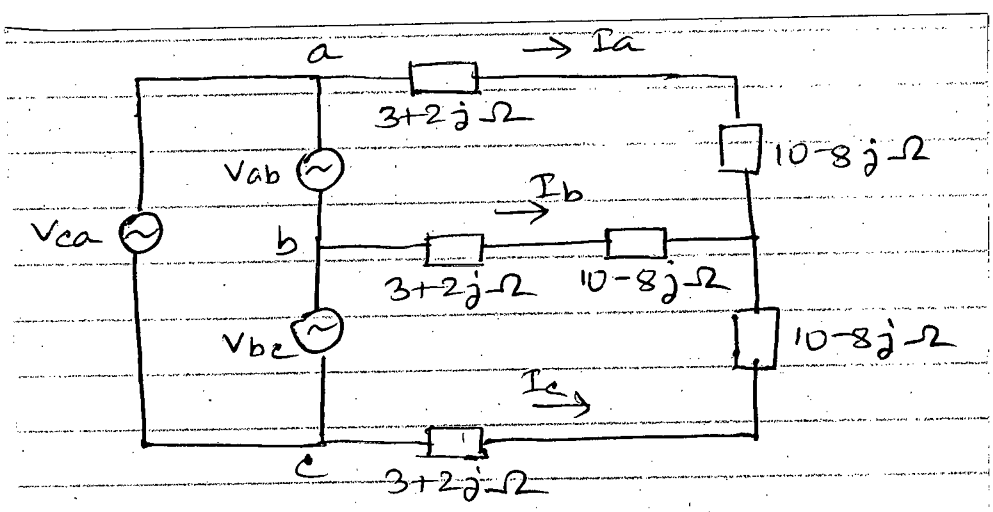


Fig. for Q. 4(b).

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) What are the causes of errors in current transformers? How to reduce those errors? **(12)**

(b) For an instrumentation amplifier, show that

$$\frac{v_o}{E_1 - E_2} = 1 + \frac{2}{a},$$

where 'E' and 'E_2' are voltages applied to the positive and negative inputs respectively, 'Vo' is the output voltage and 'a' vs the ratio between the resistance of the potentiometer and feedback resistance. **(17)**

EEE 269

Contd ... Q. No. 5

(c) How can you use a differential amplifier to design an electronic voltmeter? **(6)**

6. (a) For a piezo-electric transducer show that E_o = gtp, where E_o = output voltage, t = thickness of the crystal, g = voltage sensitivity, P = applied pressure or stress. **(15)**

(b) A quartz piezo-electric crystal having a thickness of 2 mm and voltage sensitivity of 0.055 V-m/N is subjected to pressure of 1.5 MN/m^2. Calculate voltage output. If the permittivity of quartz is 40.6 × 10^{-12} F/m, calculate its charge sensitivity. **(10)**

(c) Write short notes on the following: **(10)**

(i) Thermistors

(ii) Thermocouples

(iii) Digital display

7. A 460 V, 25 HP, 60 Hz, 4-pole, Y-connected induction motor has the following impedances in ohms per phase referred to the stator circuit: **(35)**

$R_1 = 0.641\ \Omega$, $R_2 = 0.332\ \Omega$,

$X_1 = 1.106\ \Omega$, $X_2 = 0.464\ \Omega$,

$X_m = 26.3\ \Omega$,

The rotational losses are 1100 W and are assumed to be constant. The core loss is lumped in with the rotational losses. For a rotor slip of 2.2 % at the rated voltage and rated frequency. Find the

(i) speed of the motor, (ii) stator current, (iii) power factor (iv) mechanical power developed by the motor (v) torque developed by the motor (vi) active power supplied to the rotor and power lost in the rotor conductors. (vii) reactive power absorbed by the motor.

8. (a) With proper diagrams and explanations, develop the equivalent circuit of synchronous generator. **(14)**

(b) Draw the phasor diagram of a synchronous motor operating at a leading power factor. (Do not neglect R_A). **(6)**

(c) A 480 V, 50 Hz, Y-connected six pole synchronous generator has a per phase reactance of 1 Ω. Its full load armature current is 60 A at 0.8 p.f. lagging. This generator has friction and windage losses of 1.5 kW and core losses of 1 kW at 60 Hz at full load. I^2R losses are negligible. The field current is adjusted so that the terminal voltage is 480 V at no load. **(15)**

(i) What is the speed of rotation of this generator?

(ii) What is the terminal voltage if it is loaded with the rated current at 0.8 p.f. leading?

(iii) What is the input torque to be generated for the condition given in (ii).