L-2/T-2/CSE Date : 22/07/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

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

Full Marks: 140 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Construct the state transition diagram for a Turning machine to compute the following subtract function: $f(x, y) = x - y$, where $x \geq y$. Assume that the numbers are represented in a modified version of unary number system where each number N is represented by repeating the symbol '1' $N + 1$ times. For example, the number 1 is represented as 11, the number 2 is represented as 111 and the number 0 is represented as 1. The Turing machine should enter the accept state after the computation. We don't care where you leave the head at the end of the computation. Your state diagram does not need to explicitly show the reject state or the transitions into it. **($8\frac{1}{3}$)**

   (b) Give the proof idea of the following statement: 'Every Turing machine with multiple tracks in its tape has an equivalent single track Turing machine'. **(7)**

   (c) Briefly explain an encoding technique for Turing machines. With the help of this encoding technique, show that the number of Turing machines is countable. **(6+2=8)**

2. (a) Construct the state transition diagram of a 2–tape Turing machine to decide the following language: L = {wcw^R: where $w \in \{a, b\}^*$ and w^R is the reverse string of w}. Your state diagram should be as simple as possible and it must use both tapes of the Turing machine. Your state diagram does not need to explicitly show the reject state or the transitions into it. **($8\frac{1}{3}$)**

   (b) Show that a language is recognized by a Turing Machine with a two way infinite tape if and only if it is recognized by a Turing Machine with a one way infinite tape. **(8)**

   (c) The halting problem can be described by the following language: **(7)**

   L = {<M,w> : M is a Turing machine and M halts on input string w}. Show that, the language L is Turing–acceptable.

3. (a) Give the state diagram of a Turing machine M that does the following on input string '#w' where $w \in \{0, 1\}^*$. Let n = |w| (the length of the string w). If n is even, then M converts string #w to the string #0^n (symbol 0 is repeated *n* times). If n is odd, then M converts #w to the string #1^n. The machine should enter the accept state after the conversion. We don't care where you leave the head at the end of the conversion. However, your state diagram does not need to explicitly show the reject state or the transitions into it. **($8\frac{1}{3}$)**

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(b) Prove the following statement: 'The union of two recursively enumerable languages is also recursively enumerable'. **(8)**

(c) Construct the state diagram of a push down automaton that accepts the following language: L = {w: w∈ {a, b}* and length of w is odd with middle symbol 'a'}. Example strings in the language L are: aaa, bbabb, baaba, etc. **(7)**

4. (a) Construct the state diagram of a push down automaton that recognizes the following language: $L = \{a^i b^j c^k : i + j = k\}$. **(7)**

(b) Consider the following context free grammar: $CFG = (V, \Sigma, R, S)$, where $V = \{S, T, X\}, \Sigma = \{a, b\}$, the start non-terminal is S, and the rules in R are: $S \to aTXb, T \to XTS \mid \varepsilon, X \to a \mid b$. Convert the CFG to an equivalent push down automata. **(8)**

(c) Show that, the following language L is decidable: $L = \{<A, B, C>: A, B, C\}$ are DFAs over the same alphabet Σ and $L(C) = L(A) \cup L(B)\}$. **(8⅓)**

SECTION – B

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

5. (a) Give three differences between DFA and NFA with examples. **(6)**

(b) Define regular language. Prove that the class of regular languages is closed under the following operations: **(12)**

(i) *star* operation

(ii) *concatenation* operation.

(c) Give the state diagram of a DFA that recognizes the following language: **(5⅓)**

$\{w \mid \text{the length of } w \text{ is at most } 5\}$ where $\Sigma = \{0, 1\}$

6. (a) Is there any technique to test whether a given language *L* is regular or not? State and prove it. **(13⅓)**

(b) Prove that the following languages are not regular: **(10)**

(i) $L_1 = \{www \mid w \in \{0,1\}^*\}$

(ii) $L_2 = \{1^{n^2} \mid n \geq 0\}$

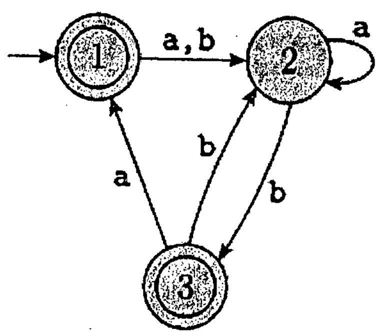
Contd P/3

CSE 211

7. (a) Construct an NFA that recognizes the language $(01 \cup 001 \cup 010)^*$. **(8)**

(b) Convert the NFA derived in 7(a) into an equivalent DFA. Give the state diagram of this DFA with only states reachable from the start-state. **(8)**

(c) The state diagram of a finite automaton is given below. Derive the regular expression for it. **($7\frac{1}{3}$)**



8. (a) Formally define context-free grammar. What is ambiguous grammar? Give an example. **(6)**

(b) Design a context-free grammar for each of the following languages: **(10)**

(i) $\{0^n1^n \cup 1^n0^n \mid n \geq 0\}$

(ii) $\{w \mid w \in \{0, 1\}^*$ and w contains at least three 1's$\}$

(c) The set of rules R of a context-free grammar ({E, T, F}, {a,b,+,*,(,)}, R, E) is given below: **($7\frac{1}{3}$)**

E → E+T | T

T → E*F | F

F → (E) | a | b

Show the steps of derivation of the expression ((a+b)*b).

Also, show the parse-tree for it.

L-2/T-2/CSE Date : 06/07/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

Sub : **CSE 207** (Algorithms)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

There are **NINE** questions in this section. Answer any **SEVEN**.

1. "Search spaces for natural combinatorial problems tend to grow exponentially with the size of the input" — explain and justify with necessary examples. **(15)**

2. Prove that greedy method stays ahead in interval scheduling problem. And hence show that greedy method returns an optimal set of jobs. **(15)**

3. Prove that if we use greedy algorithm for interval partitioning problem, every interval will be assigned a label, and no two overlapping intervals will receive the same label. **(15)**

4. Explain how Dijkstras algorithm can be implemented using priority queue. Find out the running time for this algorithm. **(15)**

5. Put down and prove the "cut property" and "cycle property". Explain with necessary examples how these properties are useful in solving the minimum spanning tree problem. **(15)**

6. Describe with necessary elaboration on the required operations and data structure, how the union-find data structure can be used for Kruskal's algorithm. **(15)**

7. We have Union-Find data structure for some set S of size n, where unions keep the name of the larger set. Prove that for array implementation any sequence of k Union operations takes at most $O(k \log k)$ time. Also prove that for pointer-based implementation, a Find operation takes $O(\log n)$ time. **(15)**

8. For a ranking of "7, 9, 1, 5, 4", discuss how the algorithm for finding inversion counts using the divide and conquer approach will work. Show the various procedure calls and returned values using a neat schematic diagram. In a division process, you can put $\lceil n/2 \rceil$ elements in the left half, and $\lfloor n/2 \rfloor$ elements in the right half, where n is the number of elements being divided. Then find out the running time of this algorithm. **(15)**

9. In the finding the closest pair of points problem using the divide and conquer approach, if q is a point in the left half and r is a point in the right half, and $d(q,r) < \delta$, where δ is the minimum of distances in each half, then show that each of q and r lies within a distance δ of the line dividing the two halves. Hence show that q and r are within 11 positions of each other in a list sorted in y coordinate. **(15)**

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SECTION – B

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

10. (a) Compare the properties of problems that can be solved with greedy method, divide-and-conquer method and dynamic programming method. **(8)**
(b) Write and prove the optimal-substructure property of the matrix chain multiplication problem. Calculate the number of parenthesizations of a sequence of n matrices. **(5+5=10)**
(c) Let $X = \langle x_1, x_2, \ldots x_m \rangle$ and $Y = \langle y_1, y_2, \ldots y_n \rangle$ be sequences, and let $Z = \langle z_1, z_2, \ldots z_k \rangle$ be any LCS of X and Y. If $x_m \neq y_n$ and $z_k \neq x_m$, then prove that Z is an LCS of X_{m-1} and Y. **(7)**
(d) Find an LCS of $X = \langle \text{ATCTGAT} \rangle$ and $Y = \langle \text{TGCATA} \rangle$ by showing the c and b tables. **(10)**

11. (a) Write and prove the max-flow min-cut theorem. **(10)**
(b) Explain why one can solve the fractional knapsack problem by a greedy strategy, but one cannot solve the 0-1 knapsack problem by such a strategy. **(10)**
(c) Find an optimal solution to the 0/1 knapsack instance of $n = 4$, $W = 6$, $(v_1, v_2, v_3, v_4) = (50, 30, 12, 45)$, and $(w_1, w_2, w_3, w_4) = (2, 3, 1, 3)$. **(15)**

12. (a) What are the traveling-salesman problem, Euler tour problem and Hamiltonian cycle problem? If $L_1 \leq_p L_2$ and $L_2 \leq_p L_3$, then prove that $L_1 \leq_p L_3$. **(3+7=10)**
(b) What is a flow network? What is the maximum-flow problem? Explain how one can convert a multiple-source, multiple-sink maximum-flow problem into a problem with a single source and a single sink. **(4+2+4=10)**
(c) Write the Ford-Fulkerson algorithm for solving the maximum-flow problem, and analyze the time-complexity of the algorithm. Explain how the Edmonds-Karp algorithm improves the bound of the Ford-Fulkerson algorithm. **(10+5=15)**

13. (a) Define the following six classes of problems: P, Co-P, NP, Co-NP, NPC and NP-hard. By a diagram show the relationship among P, Co-P, NP, Co-NP and NPC that most researchers regard as the most likely. **(6+4=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 any NP-complete problem is polynomial-time solvable, then prove that P = NP. **(7+3=10)**
(c) Write a polynomial-time 2-approximation algorithm for the vertex-cover problem, 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. **(8+7=15)**

L-2/T-2/CSE **Date : 21/09/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

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**.

All the symbols have their usual meanings.

1. (a) What are the basic differences between BJT and MOS transistors? **(6)**

   (b) Explain the operation of the CMOS NAND gate. **(10)**

   (c) Simplify the following function and draw the circuit diagram using NMOS gates: **(10)**

   $$Y = (AB + C)' \cdot (CE + D')'$$

   (d) How can you implement the above mentioned function in 1(c) using CMOS gates? **(9)**

2. (a) Explain the operation of Dynamic NMOS inverter. How can you use it to design two-phase rationed dynamic NMOS shift register? **(6+7)**

   (b) Explain the read and write operations of the Four-MOSFET dynamic RAM cell using necessary circuit diagram. **(10)**

   (c) Draw the I^2L interconnection diagram to generate the following functions: **(3×4=12)**

   (i) $Y_1 = \overline{A + B}$

   (ii) $Y_2 = (A \cdot B)'$

   (iii) $Y_3 = AB + A'B'$

3. (a) Draw the circuit diagram of a diode-logic AND gate (positive logic) and derive its output voltage equation. **(7)**

   (b) Find out $h_{FE\,(min)}$, NM(0), NM(1), P(0) and P(1) of the following DTL NAND gate. If the h_{FE} = 35, then find out the fanout of this circuit (Assume silicon transistor and diodes). **(3×6=18)**

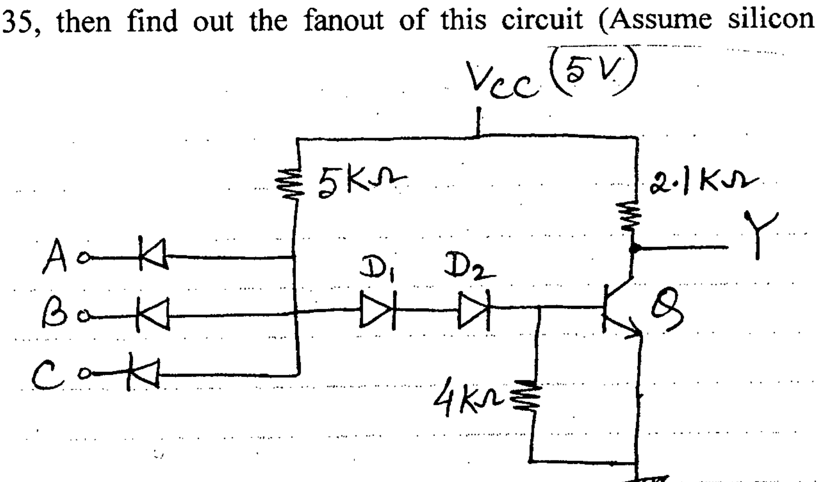

Fig: DTL NAND gate.

   (c) How to design a DTL NAND gate with increased fan-out? Explain with figure. **(10)**

CSE 209

4. (a) What are the limitations of DCTL gates? What are the advantages of using such gates? **(6)**
(b) Draw the circuit diagram of a difference amplifier along with the transfer characteristics. Derive the expressions for collector current and emitter current of such an amplifier. **(10)**
(c) What is the basic differences between active pull-up and passive pull-up circuit in TTL logic? Explain with necessary figures. **(7)**
(d) Why is the switching time of TTL gate quite low? **(6)**
(e) How the noise-immunity is improved in HTL gates? Explain using figure. **(6)**

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**.
While you draw wave-shapes, always mention the pick values, horizontal and vertical scaling and any other things necessary to understand the wave-shape clearly.

5. (a) For the circuit and input waveform shown in Figure 5(a), draw the corresponding output wave-shape. Show the necessary calculations briefly. **(15)**
(b) For the Triangular Wave Generator of Figure 5(b)-A, if the triangular wave-shape generated by it resembles the wave-shape of Figure 5(b)-B, write down the mathematical expression to calculate T_1 and T_2. Then numerically calculate T_1, T_2 and T_1/T_2. **(12)**
(c) Draw the schematic diagram of a R-2R ladder D/A converter. What is its benefit over weighted resistor D/A converter? **(6+2=8)**

6. (a) For the **low phase** circuit and input waveform shown in Figure 6(a), derive a formula to determine the corresponding output waveform. **(13)**
(b) For the circuit and input waveform shown in Figure 6(a), draw the corresponding output wave-shape. Show the necessary calculations briefly. [Hint: The formula derived in Question 6(a) may be useful]. **(15)**
(c) For the circuit and input waveform shown in Figure 6(c), draw the corresponding output wave-shape. Show the necessary calculations briefly. **(7)**

7. (a) For the square wave generator of Figure 7(a), non-identical avalanche diodes V_{z1} and V_{z2} are used. If the output is either $+V_{01}$ or $-V_{02}$, where $V_{01} = V_{z1} + V_D$ and $V_{02} = V_{z2} + V_D$, verify that the duration of the positive section is given by **(13)**

$$T_1 = RC \ln\left(\frac{1+\dfrac{\beta V_{02}}{V_{01}}}{1-\beta}\right)$$

Similarity, derive the formula for T_2.

Contd P/3

CSE 209

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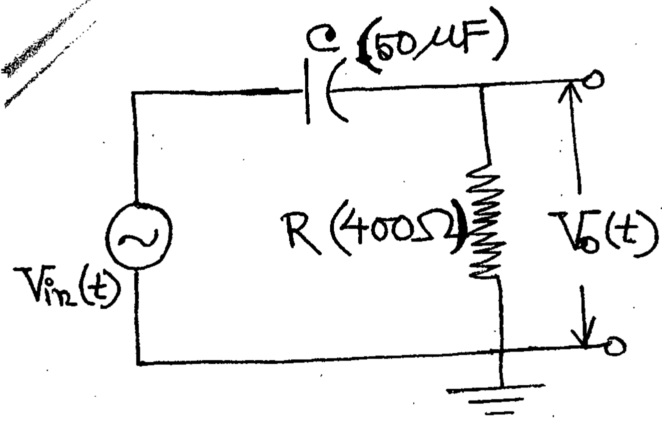
(b) When a symmetrical square wave with zero mean (as shown in Figure 7(b)-A) is applied as an input to a RC **high-pass** circuit, it is known that the corresponding output wave-shape is resembled by Figure 7(b)-B. Now, with reference to Figure 7(b)-A and 7(b)-B, prove that, $V_1 = -V_2$. **(14)**

(c) Mathematically prove that, if RC is kept high enough, i.e. **RC>>>t**, then the output of a **high-pass** RC circuit almost mimics the input. **(8)**

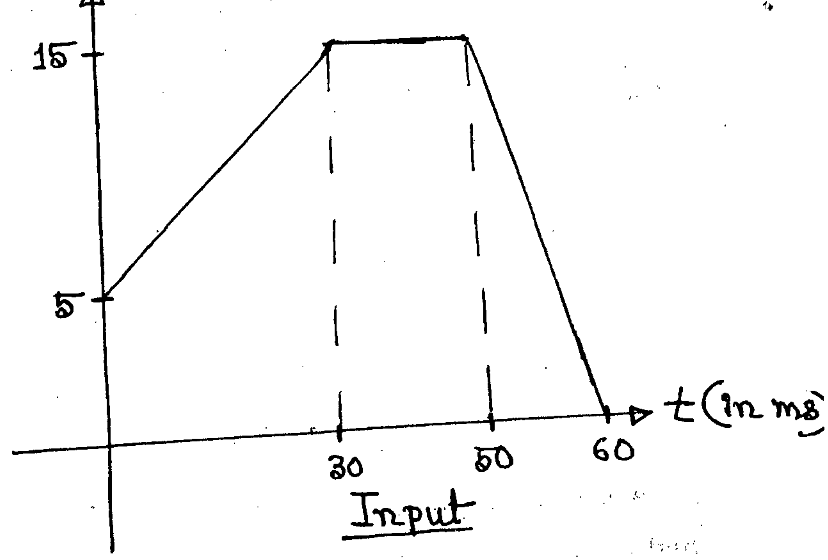
8. (a) Draw the schematic diagram of a 4-bit Parallel-Comparator A/D converter and write down the corresponding truth table. **(8)**

(b) In the circuit of Figure 8(b), $C = 0.1\ \mu F$, $R = 10\ K\Omega$ and diode has $R_r = \infty$, $R_f = 1000\ \Omega$ and $V_\gamma = 0$. The input is a symmetrical square wave of frequency 1 KHz operating between the levels –150 and –100 V and beginning at –150 V at t = 0. Assume that the capacity is initially charged at –20 V. Draw the waveform of $V_o(t)$ from t = 0 through the first two cycles during which the diode conducts. Label all voltage levels. **(20)**

(c) If RC is kept high enough, i.e. RC>>>t and the input wave-shape is sinusoidal, then what will be the behavior of the corresponding output wave-shape in a RC **low-pass** circuit? Show mathematical reasoning behind your answer. **(7)**

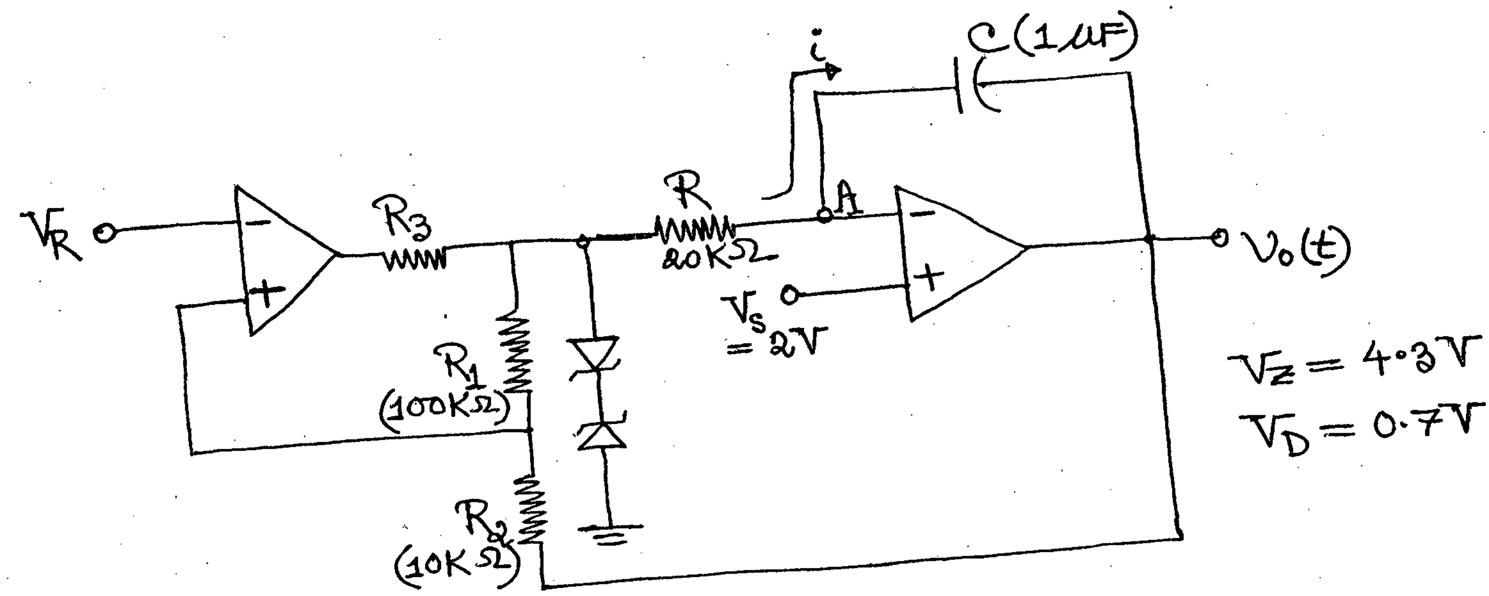


Circuit

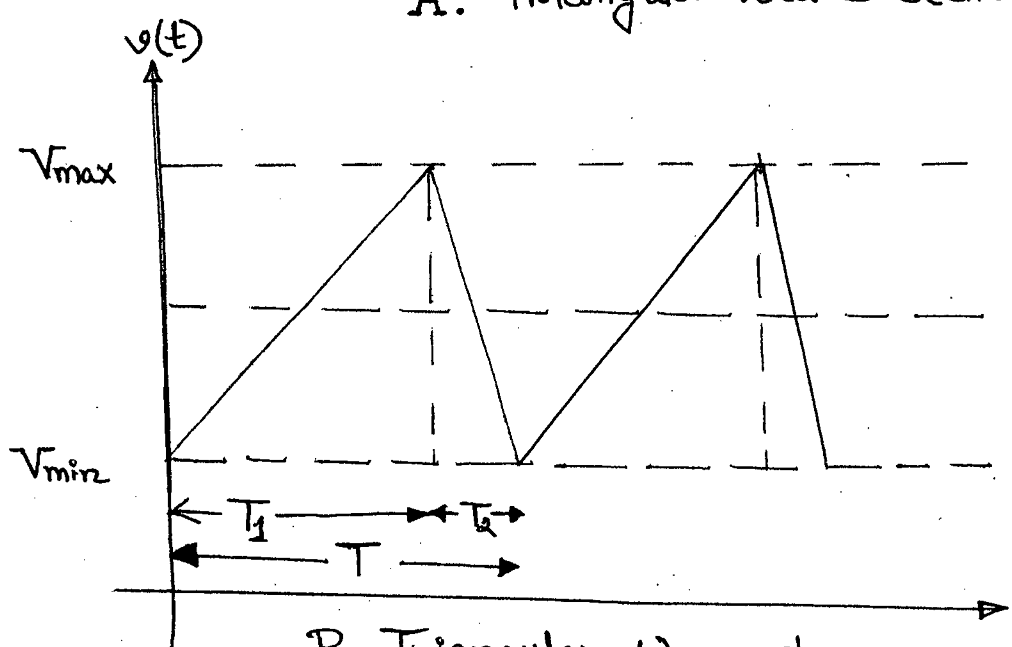


Input

Figure for Question No. 5(a)



A. Triangular Wave Generator



B. Triangular Wave-shape

Figure for Question No. 5(b)

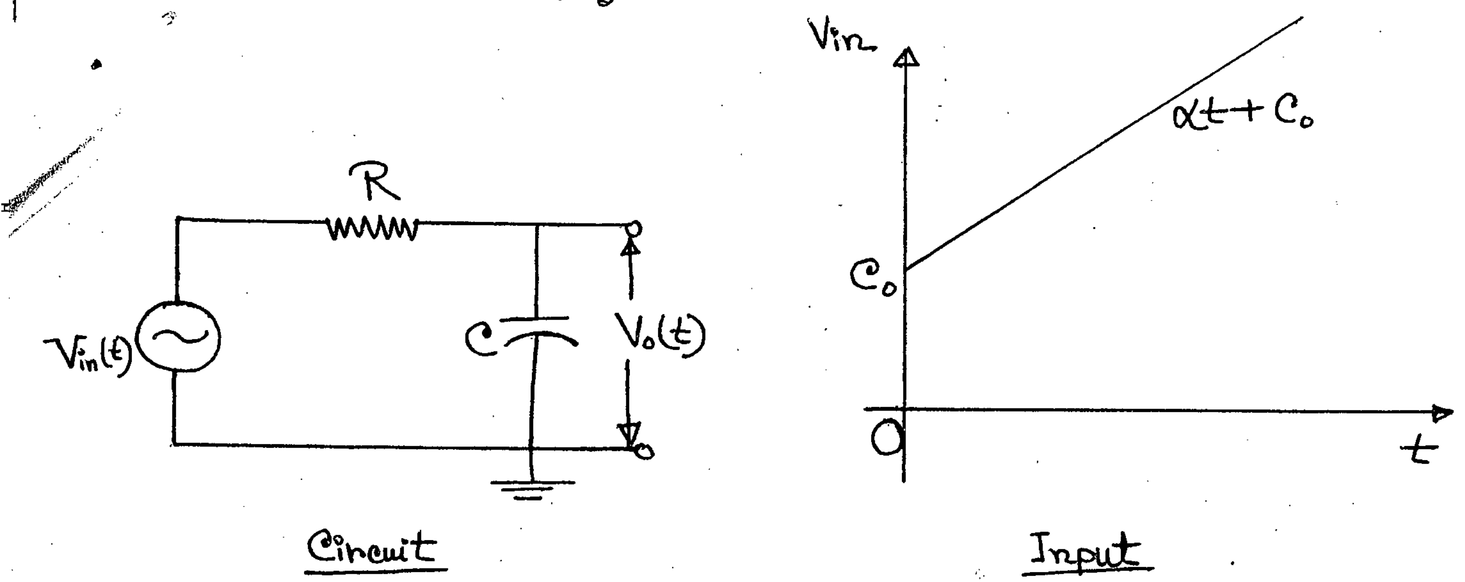


Figure For Question No. 6(a)

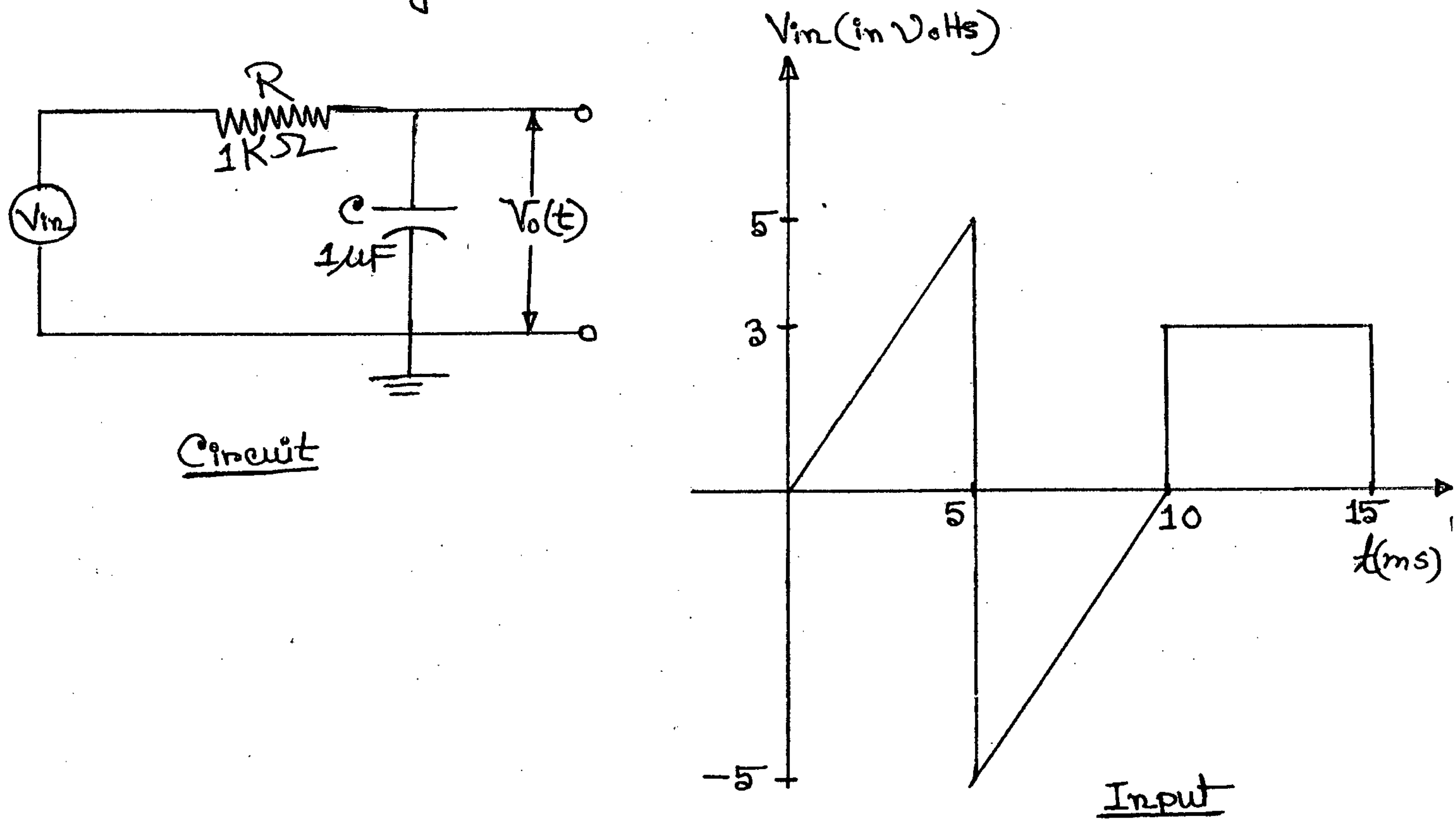


Figure For Question No. 6(b)

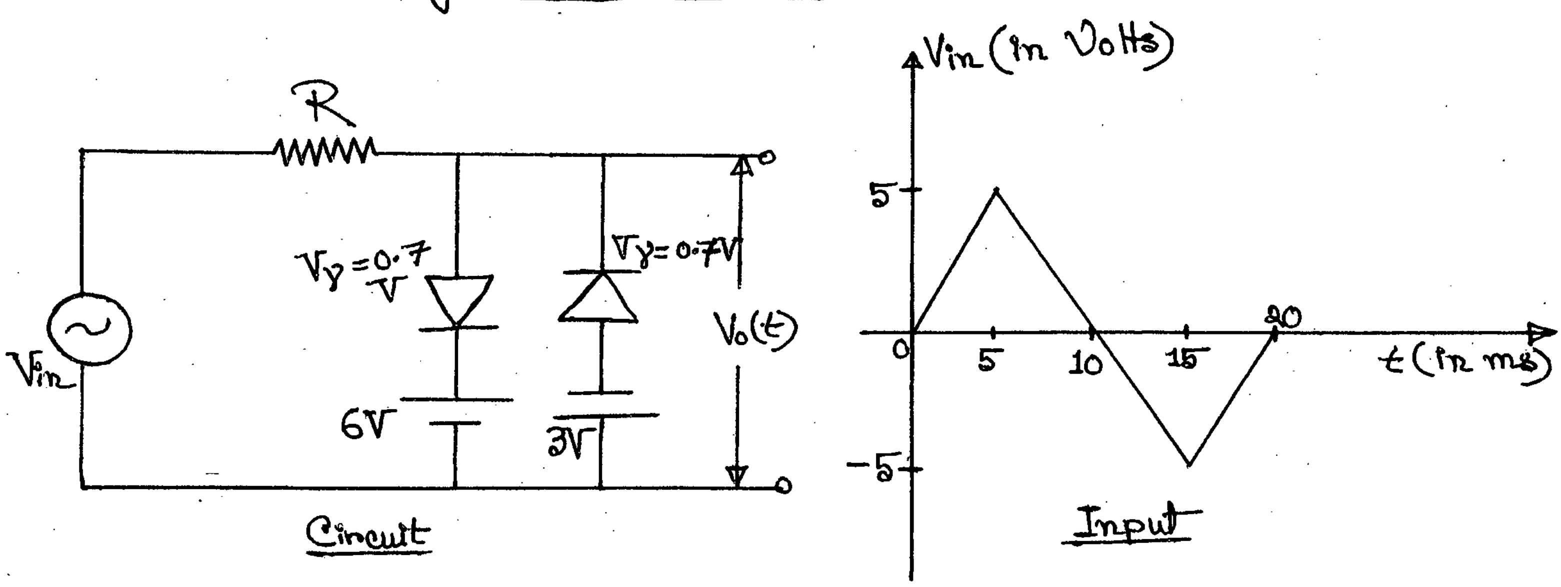


Figure for Question No. 6(c)

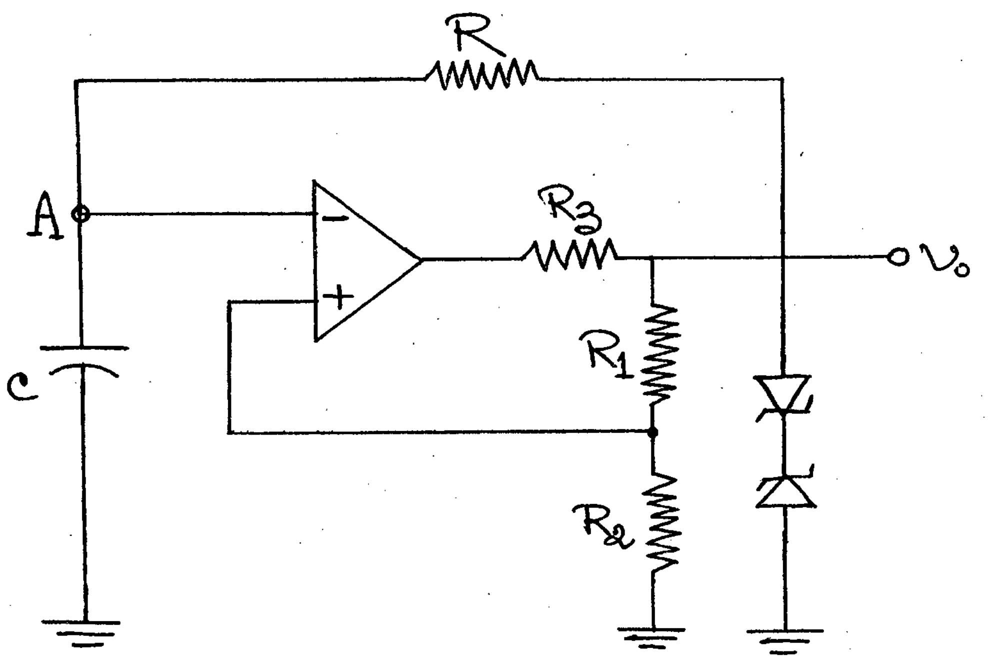


Figure for Question No. 7(a)

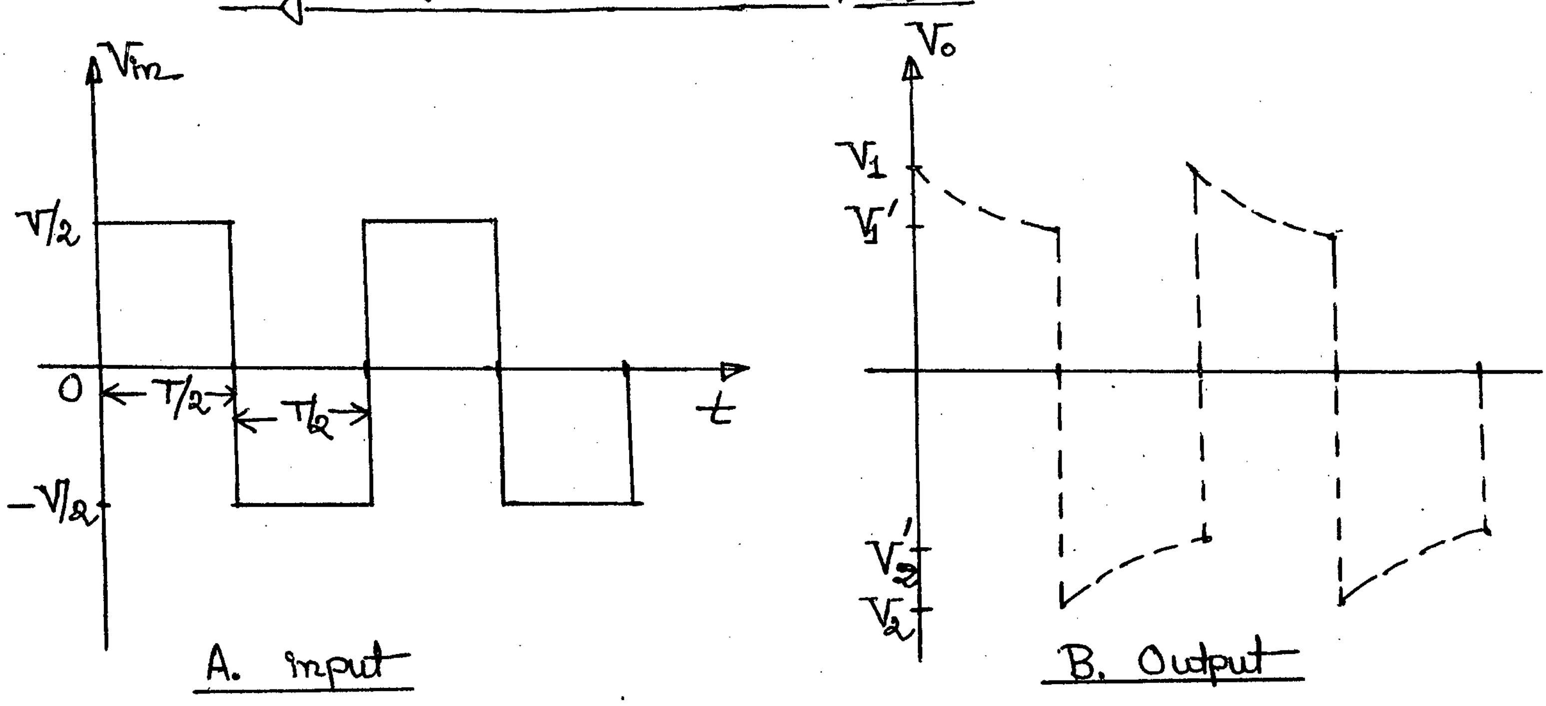


Figure for Question No. 7(b)

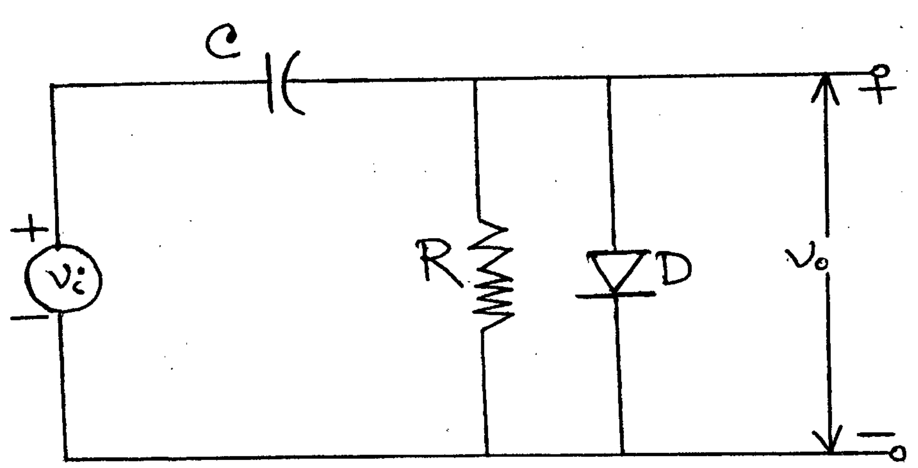


Figure for Question No. 8(b)

Jonmoon
28.9.13

L-2/T-2/CSE **Date : 28/09/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

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

Full Marks: 280 Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

Symbols used have their usual meaning.

SECTION – A

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

1. (a) Reduce the matrix A to canonical form and hence find the rank of the matrix, where **(16⅔)**

$$A = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 2 & 7 & 3 & 5 \\ 3 & 8 & 1 & -2 \\ 2 & 4 & 6 & 8 \end{pmatrix}$$

(b) Solve the following system by reducing augmented matrix to its canonical form: **(15)**

$$3x + 5y - 7z = 13$$
$$4x + y - 12z = 6$$
$$2x + 9y - 3z = 20$$

(c) Consider the matrix **(15)**

$$A = \begin{pmatrix} 1 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 1 \end{pmatrix}$$

and $P(x) = x + 2x^{-1} - 4$. Find $P(A)$.

2. (a) Find non-singular matrices P and Q such that PAQ is in a normal form, where **(20)**

$$A = \begin{pmatrix} 1 & 2 & -1 & 2 \\ 3 & 1 & -2 & -1 \\ 4 & -3 & 1 & 1 \end{pmatrix}.$$

(b) Find all eigenvalues and the corresponding eigenvectors of the matrix **(26⅔)**

$$A = \begin{pmatrix} 4 & 6 & 6 \\ 1 & 3 & 2 \\ -1 & -4 & -3 \end{pmatrix}$$

Also find the matrix P that diagonalizes A and hence determine the corresponding diagonal matrix $P^{-1}AP$.

Contd P/2

MATH 243

3. (a) Use Cayley-Hamilton theorem to find the inverse of the matrix **(16⅔)**

$$A = \begin{pmatrix} 1 & 2 & 2 \\ 3 & 1 & 0 \\ 1 & 1 & 1 \end{pmatrix}$$

(b) Consider the basis $S = \{\overline{u}, \overline{v}, \overline{w}\}$ for R^3, where $\overline{u} = (1,1,1)$, $\overline{v} = (1,1,0)$, $\overline{w} = (1,0,0)$ and let $T: R^3 \to R^3$ be the linear transformation such that $T(\overline{u}) = (2,-1,4)$, $T(\overline{v}) = (3,0,1)$ and $T(\overline{w}) = (-1,5,1)$. Find a formula for $T(x, y, z)$ and use it to find $T(2,-3,5)$. **(15)**

(c) Let $T: R^4 \to R^3$ be the linear transformation defined by **(15)**

$$T(x, y, s, t) = (x - y + s + t, x + 2s - t, x + y + 3s - 3t).$$

Find a basis and the dimension of (i) Null space of T and (ii) Range space of T.

4. (a) Consider the vector space R^3. Find the coordinate vector of $\underline{v} = (3,1,-4)$ relative to the basis $\{(1,1,1), (0,1,1), (0,0,1)\}$. **(10)**

(b) Define linear dependence of vectors. Show that the vectors $\overline{u} = 2\hat{i} + \hat{j} - 3\hat{k}$, $\overline{v} = \hat{i} - 4\hat{k}$ and $\overline{w} = 4\hat{i} + 3\hat{j} - \hat{k}$ are linearly dependent. Also, determine a relation among them. **(16⅔)**

(c) Show that the four points whose position vectors are $3\hat{i} - 3\hat{j} + 4\hat{k}$, $6\hat{i} + 3\hat{j} + \hat{k}$, $5\hat{i} + 7\hat{j} + 3\hat{k}$ and $2\hat{i} + 2\hat{j} + 6\hat{k}$ are coplanar. **(10)**

(d) Prove that $(\overline{a} \times \overline{b}) \cdot (\overline{b} \times \overline{c}) \times (\overline{c} \times \overline{a}) = (\overline{a} \cdot \overline{b} \times \overline{c})^2$. **(10)**

SECTION – B

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

5. (a) Evaluate $\iint_S \underline{F} \cdot \hat{n}\, dS$ where $\underline{F} = 4xz\underline{i} - y^2\underline{j} + yz\underline{k}$ and S is the surface of the cube bounded by the planes $x = 0, x = 1, y = 0, y = 1, z = 0, z = 1$. **(20⅔)**

(b) Apply Green's theorem in the plane to evaluate $\oint_C [(2x^2 - y^2)dx + (x^2 + y^2)dy]$, where C is the boundary of the curve enclosed by the x-axis and semi-circle $y = \sqrt{(1 - x^2)}$. **(13)**

(c) Verify Stokes theorem for $\underline{F} = (x^2 + y^2)\underline{i} - 2xy\underline{j}$ taken round the rectangle bounded by $x = \pm a, y = 0, y = b$. **(13)**

MATH 243

6. (a) Evaluate: **(24)**

(i) $L\left\{\int_0^t f(u)\,du\right\}$

(ii) $L\left\{\dfrac{f(t)}{t}\right\}$

(iii) $L\{J_0(at)\}$.

(b) Using Laplace transformation, show that **(16⅔)**

$$\int_0^{\infty}\frac{e^{-xt}}{(1+t)\sqrt{t}}\,dt=\pi e^{t}\,erfc\left(\sqrt{t}\right).$$

(c) Find $L^{-1}\left\{\dfrac{1}{\left(s^2+2s+5\right)^{3/2}}\right\}$. **(6)**

7. (a) Using Laplace transformation evaluate $\dfrac{1}{\pi}\int_0^{\pi}\cos(t\cos\theta)\,d\theta$. **(16)**

(b) Solve (using Laplace transformation): **(30⅔)**

$$\begin{cases}2x(t)-y(t)-y'(t)=4\left(1-e^{-t}\right)\\ 2x(t)+y(t)=2\left(1+3e^{-2t}\right)\end{cases}$$

$x(0)=y(0)=0$.

8. (a) Obtain a Fourier series of the function $f(x)=x^2$ defined in the interval $(-\pi<x<\pi)$ and hence evaluate $\sum_{n=1}^{\infty}\dfrac{(-1)^{n+1}}{n^2}$. **(12)**

(b) Find the Fourier cosine integral of $f(x)=e^{-x}\cos x;\ (x>0)$ and hence evaluate the integral $\int_0^{\infty}\dfrac{\omega^2+2}{\omega^4+4}\cos\omega x\,d\omega$. **(14)**

(c) Use Fourier transform to solve the following boundary value problem: **(20⅔)**

$$\frac{\partial u}{\partial t}=\frac{\partial^2 u}{\partial x^2};\qquad 0<x<6,\ \ t>0$$

subject to the condition $u(0,t)=u(6,t)=0;\,t>0$ and $u(x,0)=x(1-x);\,0<x<6$.

Shasan
5-10-13

L-2/T-2/CSE **Date : 05/10/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-2/T-2 B. Sc. Engineering Examinations 2011-2012

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) With neat diagrams, describe the construction and operation of mechanical resonance type frequency meter. **(15)**

(b) At a location in Europe, it is necessary to supply 300 kW power at 60 Hz. The only power sources available operate at 50 Hz. It is decided to generate the power by means of a motor-generator set consisting of a synchronous motor driving a synchronous generator. How many poles should each of the two machines have in order to convert 50 Hz power to 60 Hz power? **(10)**

(c) Draw the full equivalent circuit of a synchronous motor and express the internal generated voltage in terms of terminal voltage and motor parameters. **(10)**

2. (a) A 2300 V 1000 kVA 0.8 PF lagging 60 Hz two pole Y-connected synchronous generator has a synchronous reactance of 1.1 Ω and an armature resistance of 0.15 Ω. At 60 Hz, its friction and windage losses are 24 kW and core losses are 18 kW. The field circuit has a dc voltage of 200 V and the maximum field current is 10 A. The resistance of the field circuit is adjustable over the range from 20 Ω to 200 Ω. The OCC of the generator is shown in Fig. for Q. 2(a). **(15)**

   (i) How much field current is required to make terminal voltage equal to 2300 V at no load?

   (ii) What is the internal generated voltage of this machine at rated conditions?

   (iii) How much field current is required to make terminal voltage equal to 2300 V when the generator is running at rated conditions?

   (iv) How much power must the generator's prime mover be capable of supplying?

(b) What is thermistor? What materials are usually used to make thermistors? Describe the construction and operation of a thermistor. **(10)**

(c) Describe the basic principles of synchronous motor operation with neat diagrams. **(10)**

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3. (a) A 2300 V 1000 kVA 0.8 PF lagging 60 Hz two pole Y-connected synchronous generator has a synchronous reactance of 1.1 Ω and armature resistance of 0.15 Ω. At rated frequency the friction and windage losses are 24 kW and core losses are 18 kW. Assume that, the field current is set at 4.5 A. [Use the OCC curve of Fig. for Q. 2(a) if needed] **(15)**

   (i) What will be the terminal voltage if a Δ-connected load of $20\angle 30^{\circ}\Omega$ is connected?

   (ii) What will be the efficiency at these conditions?

   (iii) If another identical Δ-connected load is paralleled with the first one, what will be the terminal voltage?

   (iv) What could be done to restore the terminal voltage to its original value?

   (b) Name different types of display units and describe the operation of any one type. **(10)**

   (c) A 480 V 60 Hz 400 hp 0.8 PF-leading six-pole Δ-connected synchronous motor has a synchronous reactance of 1.1 Ω and negligible armature resistance. Ignore its friction, windage and core losses. If the motor is initially supplying 400 hp at 0.8 PF lagging, what are the magnitudes and angles of E_A and I_A? If $|E_A|$ is increased by 15%, what will be the new power factor? The symbols bear their usual meanings. **(10)**

4. (a) A 2300 V 1000 kVA 0.8 PF lagging 60 Hz two-pole Y-connected synchronous generator has a synchronous reactance of 1.1 Ω and armature resistance of 0.15 Ω. The total core, friction and windage losses are 42 kW. Assume that the field current is adjusted to achieve rated terminal voltage at full load condition. **(15)**

   (i) What is the efficiency at rated load?

   (ii) Given that "voltage regulation" is given by the following equation

$$VR = \frac{\text{Termial Voltage - Rated Terminal Voltage}}{\text{Rated Terminal Votlage}} \times 100\%$$

   calculate the VR at rated conditions.

   (iii) What will be the VR if the generator is loaded with rated kVA with 0.8 PF leading?

   (iv) What will be the VR if the generator is loaded with rated kVA at unity PF?

   (b) With necessary and neat diagrams, describe the operation and construction of piezo-electric transducers. **(10)**

   (c) A 208 V 45 kVA 0.8 PF-leading 60 Hz Δ-connected synchronous motor has a synchronous reactance of 2.5 Ω and a negligible armature resistance. The friction and windage losses are 1.5 kW and core losses are 1.0 kW. Initially the shaft is supplying a 15-hp load at 0.8 PF leading. Calculate the E_A and I_A. If the shaft load is increased to 30 hp, what will be the new power factor? The symbols bear their usual meanings. **(10)**

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SECTION – B

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

5. (a) With diagrams, explain the necessity of commutation in a dc motor. Also, mention how commutation is performed in dc machines. Describe the factors that can control the speed of a dc motor. **(20)**

   (b) A 110 V dc shunt motor has an armature resistance of 0.3 Ω, a field circuit resistance of 52 Ω, and draws a line current of 29 A at full load. The rated full load speed for the motor is 1600 rpm and its brush voltage drop is 1.8 V. Calculate **(15)**

   (i) speed of the motor at one-fourth of full load,

   (ii) speed of the motor at an overload of 120%.

6. (a) For a balanced wye-delta three phase ac system, prove that the line currents lag the corresponding phase currents by 30°. **(15)**

   (b) For the balanced three phase system shown in the figure, the voltage $V_{ab} = 125\angle 0^\circ$ V. The source voltages in the system follows a positive phase sequence. Find all phase voltages/currents and line voltages/currents existing in the system. Also, calculate the total complex power, total real power, and total reactive power delivered to the load. **(20)**

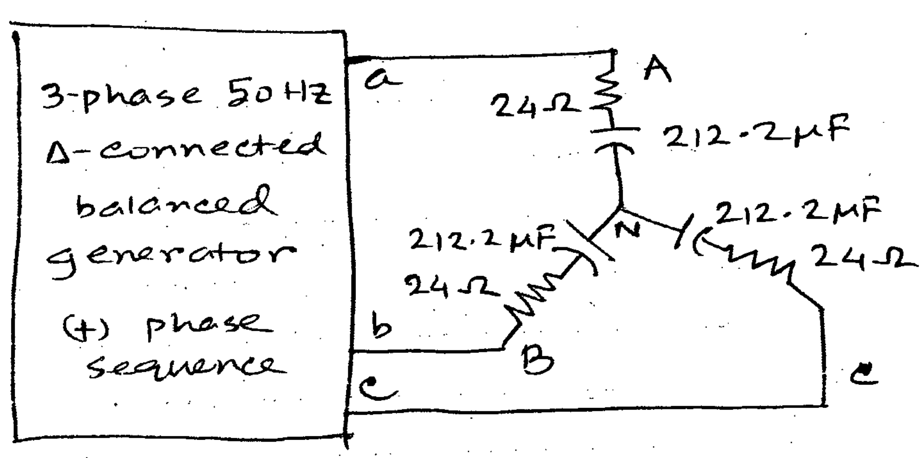

Fig. for Q. 6(b)

7. (a) Name a few criteria that are used to classify commercial transformers. Explain why a transformer is considered as a 'versatile' electrical machine. **(12)**

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(b) Prove that a single phase transformer can be used as an impedance multiplier. A 10 kVA 3600–240 V 50 Hz transformer has a magnetic core of 40 cm^2 cross section and a mean length of 89 cm. When rated voltage is applied to its high tension side, it creates a magnetic flux density of 1.8 T and a field intensity of 390 A-t/m. Calculate the no. of turns in the transformer coils and its magnetizing current. **(23)**

8. (a) Why a three-phase ac system is necessary for an electrical power system? With diagrams explain how a 3-phase ac supply can create a rotating magnetic field in an induction motor. **(20)**

(b) How can you change the direction of rotation in a three phase induction motor? Name different types of ac motors you have studied and explain the major differences between them. **(15)**

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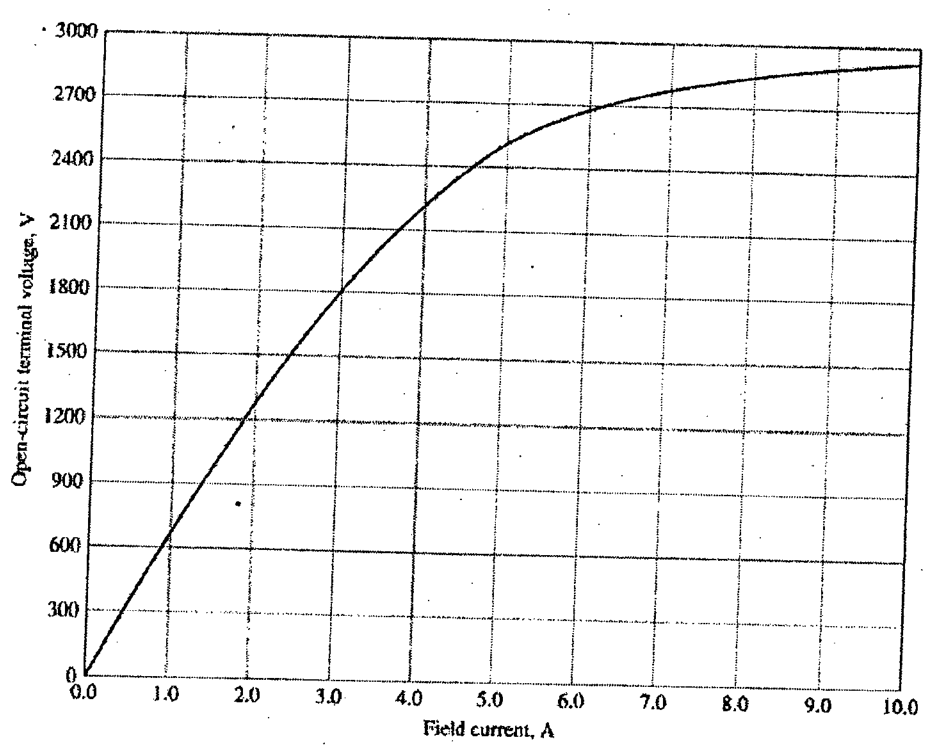

Fig. for Q.2(a)