19/12/12

L-4/T-2/EEE **Date : 18/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 459** (Optoelectronics)

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) Draw E-k diagram of Si and GaAs semiconductors and compare their optoelectronic properties obtained from E-k diagram. Why III-V compounds are very important in optoelectronic applications? **(20)**

   (b) Distinguish between 'Characteristic' and 'non-characteristic' luminescence. Explain possible mechanism for electroluminescence emission involving avalanche process. **(15)**

2. (a) Show a schematic of a DH stripe contact ELED designed to emit at 1.55 μm and indicate semiconductors used in different layers. What will be the effect on the LED output characteristics if the semiconductors used in confining and cladding layers are interchanged during fabrication process by mistake? How principle of operation of up-converter is different to that of white light LED? **(20)**

   (b) For a particular AlGaAs LED emitting at 825 nm it is found that τ_r= 50 ns and τ_{nr} = 100 ns. Calculate **(15)**

   (i) the cut-off frequency of the LED

   (ii) the internal optical power generated at a current of 100 mA. What is the composition of the AlGaAs in the LED if the bandgap of the ternary alloys $Al_xGa_{1-x}As$ follows the empirical expression,

   $E_g(eV) = 1.424 + 1.266x + 0.266x^2$.

3. (a) Draw absorption and luminescence spectra of GaAS and doped GaP. Discuss how absorption coefficient of direct /indirect semiconductors plays an important role to the external efficiency of the LED emission characteristics. What will be the linewidth in the output spectrum of a GaAs LED at room temperature if the width of the relative light intensity vs. photon energy spectrum of the LED is typically around ~ $3k_BT$? **(20)**

   (b) Distinguish between e-wave and o-wave. For Pocket's intensity modulator prove that the intensity of the detected bean, **(15)**

$$I = I_0 \ Sin^2\left(\frac{\pi}{2}\frac{V}{V_{\frac{1}{2}}}\right)$$

where the symbols have their usual meanings.

Contd P/2

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4. (a) What is transparency current ? How model purity of a laser can be achieved? Discuss both device design and material considerations. Estimate the wavelength if stimulated and spontaneous emission rates are equal at room temperature. **(20)**

   (b) A GaAs laser operating at a wavelength of 850 nm has a cavity length of 300 μm. Estimate the threshold current density for the following given data: **(15)**

   transition linewidth = 1.5×10^{13} Hz,

   loss coefficient = $3.5 \times 10^{3}\ m^{-1}$

   refractive index = 3.6

   thickness of mode volume = 2 μm

   and internal quantum efficiency = 1.

SECTION – B

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

5. (a) Which structure among p^+- n or p - n^+ is chosen for LEDs? Explain with appropriate diagrams. **(12)**

   (b) The total light output power from a particular AlGaAs red LED is 2.5 mW, when the current is 50 mA and the voltage is 1.6 V. Calculate its external conversion efficiency. **(10)**

   (c) Explain the physical origin of spectral broadening in LEDs. **(13)**

6. (a) A photodiode has the following characteristics. **(15)**

Amps-	4.2 mA,	4.8 mA,	5.1 mA,	5.4 mA,	5.7 mA	4.5 mA
Lambda-	1800 nm,	1850 nm,	1900 nm,	1950 nm,	2000 nm,	2050 nm,

   Amps- 2.7 mA

   Lambda- 2100 nm

   Draw the responsivity curve and find out the cut-off wavelength. Incident power is 6mW.

   (b) Explain, with appropriate diagrams, the operation of a photo transistor. **(10)**

   (c) Briefly explain the physical origin of gain in a photoconductor. **(10)**

7. (a) The fill-factor of a solar-cell is given by: **(20)**

$$FF = \frac{v_{oc} - \ln(v_{oc} + 0.72)}{v_{oc} + 2}, \quad where\ v_{oc} = \frac{V_{OC}}{nkT/q}$$

   is the normalized open-circuit voltage. The maximum power output from a solar-cell is $P = FF.I_{sc}.V_{OC}$ Taking $V_{oc} = 0.58$ V, $I_{sc} = 35$ mA/cm^2 [for n = 1 at room temperature.],

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Contd ... Q. No. 7(a)

Plot the power available per unit area of a solar cell from – 40°C to + 40°C in steps of 20°C. Make use of the temperature dependence of

$$V'_{oc} = V_{oc}\left(\frac{T'}{T}\right) + \frac{E_g}{q}\left(1 - \frac{T'}{T}\right).$$

(b) Why the overall efficiency of silicon solar cell is limited to 21%? How does heterojunction material help solar absorption, and hence improve solar cell efficiencies? What are the prospects for organic solar cells? **(15)**

8. (a) A single QW laser has an ultrathin active InGaAs layer of bandgap 0.70 eV and thickness 10 nm between two layers of InAlAs which has a bandgap of 1.45 eV. Effective mass of conduction electrons in InGaAs is about 0.04 m_e and that of holes is 0.44 m_e. Calculate the first and second electron energy levels above E_c and the first hole energy below E_v in the QW. What is the lasing emission wave length for this QW laser? How would this emission wavelength change, if the QW thickness were doubled, or halved? **(22)**

(b) Explain, in brief, the operation and applications of VCSELs. **(13)**

L-4/T-2/EEE Date : 18/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 459** (Optoelectronics)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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Contd P/2

EEE 459

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EEE 459

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L-4/T-2/EEE **Date : 18/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 479** (Power System Reliability)

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) Show that the variance of a random variable, x, is given by, $V(x) = E(x^2) - \{E(x)\}^2$. **(5)**

   (b) Two power systems, X and Y, are connected through a tie line of capacity 10 MW. The generation and load data of the two systems are shown below. **(30)**

System	Generation ID	Capacity (MW)	FOR	Peak load (MW)
X	G_1	10	0.2	15
	G_2	30	0.1	
Y	G_3	15	0.1	20
	G_4	25	0.3	

   Using recursive algorithm, determine $LOLP_X$, $LOLP_Y$, $LOLP_{X|Y}$, $LOLP_{Y|X}$, $LOLP_G$.

2. (a) A power system has four generators with the capacities of 100 MW, 200 MW, 300 MW and 400 MW. The FORs of the units are 0.1, 0.2, 0.1 and 0.3, respectively. The system has three load levels of 50 MW, 150 MW and 200 MW with equal probability of occurrence. Using system cumulants, determine the value of normalized random variable, N(z). **(20)**

   (b) A power system has two generators with the capacities of 200 MW and 300 MW. The FORs of the units are 0.02 and 0.03, respectively. The system has two load levels of 250 MW and 300 MW with equal probability of occurrence. Now a new generating unit with the capacity of 400 MW and a FOR of 0.04 is added to the system. Calculate the LCC of the new unit. **(15)**

3. (a) In a large system, the average number of cable faults per year per 200 km length of cable is 0.4. Consider a specified piece of cable with 20 km length. Evaluate the probabilities of 0, 1, 2, and 3 faults occurring in 30 years period. **(10)**

   (b) Two power systems, X and Y, are inter-connected through a tie line with capacity of 10 MW. Generator data and load data of the two systems are given below. **(25)**

   Generator data:

Contd P/2

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Contd ... Q. No. 3(b)

System	Unit No.	Capacity (MW)	FoR
X	1	10	0.2
	2	30	0.1
Y	1	10	0.1
	2	20	0.3

Load data:

System	Load (MW)	Probability of occurrence
X	15	0.5
	25	0.5
Y	20	0.5
	25	0.5

Using segmentation method, determine $LOLP_X$, $LOLP_Y$, $LOLP_{XIY}$, $LOLP_{YIX}$ and $LoLP_G$.

4. (a) Derive the general expressions of expected value and standard deviation of a binomial distribution. **(15)**

(b) A power system planner proposes a plan consisting two generating units of capacities 30 MW and 40 MW with FORs of 10% and 20%, respectively. The forecasted Peak demand (L) is Gaussian in nature with the following impulse equation:

$P(L) = 0.3\ \delta(L - 30) + 0.4\ \delta(L - 50) + 0.3\ \delta(L - 70)$, where p(L) = probability of occurrence of L. Evaluate LOLP of the proposed system. **(20)**

SECTION – B

There are **FOUR** questions in this Section. Answer any **THREE**. **(30)**

5. (a) A power system has the following generator and load model.

Generator model:

Generator ID	Capacity (MW)	FOR
G_1	200	0.02
G_2	300	0.03
G_3	400	0.04

Load model:

Load (MW)	Probability of Occurrence
250	0.2
350	0.3
450	0.3
550	0.2

Using recursive technique, determine LOLP of the system.

(b) Compare the segmentation method with cumulant method. **(5)**

Contd P/3

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6. (a) A power system has three generators and only three load levels as given below **(20)**

Generator Model

Generator ID	Capacity (MW)	FoR
G_1	200	0.05
G_2	300	0.04
G_3	500	0.03

Load model:

Load (MW)	Probability of Occurrence
300	P_1
400	0.4
1000	P_2

The LOLP of the system is 3.6024%. Determine the value of P_1 and P_2. Use state enumeration technique to solve the problem.

(b) A power system has two generators with the capacities of 20 MW and 30 MW. The FORs of the units are 0.2 and 0.3 respectively. The load duration curve (LDC) of the system is constructed for the period of 50 hours where load is constant at 40 MW for the whole period. Determine LOEP of the system. **(15)**

7. (a) For a Poison distribution, determine (i) the probability of failure occurring zero times in an interval (ii) the probability of failure occurring 'x' times in an interval. **(18)**

(b) Derive the general expression of expected value and standard deviation of Poisson distribution. **(17)**

8. (a) A power system has three generators with capacities of 10 MW, 10 MW and 25 MW. The FORs of the units are 0.2, 0.3 and 0.1, respectively. The system has three load levels of 15 MW, 20 MW and 25 MW, with equal probability of occurrence. Determine LOLP using segmentation method. **(30)**

(b) What are the benefits of interconnection in power systems? **(5)**

Farid Hayee 15/1/13

L-4/T-2/EEE **Date : 20/11/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 457** (VLSI II)

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) In constant voltage scaling of MOS transistor the length, width and gate oxide thickness are scaled with 1/S and the substrate doping is scaled with S, where S>1 is the scaling factor. Show that the intrinsic gate delay decreases as $1/S^2$, and dynamic power dissipation increases as S in such scaling. **(12)**

   (b) Assume a large size inverter in a 1 μm CMOS technology has W_n = 12 μm, W_p = 36 μm, $L_n = L_p$ = 1 μm, t_{gox} = 40 nm and C_{int} = 2 pF/cm. Calculate the wire length for which the interconnection capacitance becomes comparable to gate capacitance. Given ε_{ox} = 0.35 pF/cm. The symbols have their usual significance. **(6)**

   (c) Consider a 3 mm long 0.32 μm wide metal2 wire in a 180 nm process. The sheet resistance is 0.05 Ω/□ and capacitance is 0.2 fF/μm. Construct π2 model of the wire. A 10X unit sized inverter drive a 2X unit size inverter at the end of the wire. The gate capacitance is C_g = 2 fF/μm and effective on resistance is R = 2.5 KΩ. μm for NMOS. For unit sized inverter NMOS width is 4λ = 0.36 μm and PMOS width is 8λ = 0.72 μm wide. Estimate propagation delay using Elmore delay model. All symbols have their usual significance. **(17)**

2. (a) Show the cross-section of a CMOS inverter in a twin-well sub-micron CMOS process clearly indicating the (i) Lightly doped drain (LDD) implant, (i) Side-wall spacer, (iii) Shallow trench isolation and (iv) vial connecting metal and metal2. Explain the necessity of each of the above steps in a sub-micron CMOS process. **(12)**

   (b) Describe three major sources of variations of device performance in a CMOS process. What type of distribution does each of these variations have? Explain how their combined effects are modeled using the design corners. **(9)**

   (c) A digital system in a 1.2 V 100 nm process has 200 million transistors, of which 20 million are in logic gates and the remainders are in memory arrays. The average logic transistor width is 12 λ and the average memory transistor width is 4 λ . The process has high threshold (*high-V_t*) and low threshold (*low-V_t*) transistors. The *high-V_t* ~~nA/μm~~ transistors uses thicker gate oxide. The Subthrershold leakage for OFF devices is 20 nA/μm for *low-V_t* devices and 0.02 nA/μm for *high-V_t* devices.

Contd P/2

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Contd ... Q. No. 2(c)

Gate leakage is 3 nA/μm for low-V_t and 0.002 nA/μm for high-V_t devices. Memories used high-V_t devices everywhere. Logic uses *high-V_t* devices in all but 20% of the paths that are most critical for performance.

Diode leakage is negligible. Estimate the static power consumption. How could the power consumption change if the *high-V_t* devices were not available? Note that all devices exhibit gate leakage and the OFF devices contribute to subthreshold leakage. Make necessary assumptions. Symbols have their usual significance. **(14)**

3. (a) Define logical effort, electrical effort and fan out of a gate. A n-input NAND gate drive an identical NAND gate. Determine the propagation delay of the gate using linear delay model. For simplicity in calculation you may neglect the effect of internal nodes i.e. count only diffusion capacitance on the output node. **(12)**

(b) A control unit generates a signal from a unit-sized inverter. The signal must drive unit sized loads in each bit-slice of a 64-bit datapath. The designer can add inverters to buffer the signal to drive the large load. Assuming polarity of the signal does not matter show the best number of inverters to add and the delay that can be achieved. **(13)**

(c) What are the advantage of cascade voltage switch logic (CVSL) over static CMOS circuits. Show the circuit diagram of a 3-input AND/NAND gate in CVSL and discuss on the static power consumption of the circuit. **(10)**

4. (a) Explain why two dynamic CMOS gate sharing the same clock cannot be cascaded. **(5)**

(b) The sum signal of a one bit full adder can be expressed as $S_i = A_iB_iC_{i-1} + \overline{C}_i\ (A_i + B_i + C_{i-1})$, where symbols have their usual significance. Assuming that all the input signals are available, show Domino CMOS implementation of the circuit with a conventional keeper. What will be the optimum size of the keeper transistor? **(15)**

(c) Suppose that system A is controlled by ClkA that needs to transmit N-bit data words to system B, which is controlled by ClkB. Show the design of appropriate handshake circuitry with synchronizer to establish smooth communication between the two systems. Also show the timing diagram of your system. **(15)**

SECTION – B

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

5. (a) Sketch the partial products used by a radix-4 Booth-encoded multiplier to compute $14_{10} \times 13_{10}$ and show the generation of the corresponding final product. Design a Booth encoder using X_i, X_{2i} and M_i where X_i is true for ± Y, X_{2i} is true for ± 2Y and M_i is true for negative partial products. Also design a selector circuit using this encoding where, X is the multiplier and Y is the multiplicand. **(17)**

Contd P/3

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(b) A combinational circuit is sequenced with flip-flop. Determine the maximum allowable propagation delay of the combinational circuit in terms of clock period and sequencing overhead. Assume ideal clock with no skew. What will be the effect of the clock skew t_{skew} on the maximum allowable logic delay? **(10)**

(c) Design a robust static latch such that it swings rail to rail and the state noise is isolated from output noise. The input should drive MOS gate terminal not the diffusion terminal. **(8)**

6. (a) You have to design a control circuit which will swap the contents of two registers R1 and R2, when the control signal W goes to high. You can use another register R3 to temporarily hold the value of one of the register whose value will be swapped. Draw the Algorithmic state Machine (ASM) chart of the Mealy type Finite State Machine (FSM), the state assigned table and the circuit diagram of the controller. **(20)**

(b) A FSM has one input (W), one output (z) and it works on the positive edge of a clock signal. The output z is equal to 1 if during two immediately preceding clock cycles the input W was equal to 1. Otherwise the value of z is equal to 0. Draw the state diagram, the state table using ONE HOT ENCODING ~~ad~~ and derive the circuit of the FSM. **(15)**

7. (a) Consider a TWO ~~State~~ Stage CMOS operational amplifier (op-amp). Gm_1, R_1, C_1 and Gm_2, R_2, C_2 are the transconductance, output resistance and output capacitance of the 1st and 2nd stage respectively, C_c is the compensating capacitor connecting the output of the 1st and 2nd stage. Find the dc gain, the poles and zero of the circuit. **(20)**

(b) In a 2-stage CMOS op-amp, the transconductance of both the stages is 40 mA/V. Output capacitance of the first and second stages are c_1 = 100 pF and C_2 = 5 pF respectively and the output resistances are R_1 = 10 kΩ and R_2 = 15 kΩ respectively. Calculate the locations of the first pole and the second pole. If the first pole is to be moved ten times to its present location, calculate the value of the compensating capacitor required in the feedback path between the output of the 1st and 2nd stage. **(15)**

8. (a) For an op-amp modeled with two poles and one Right-Hand (R.H.) zero, prove that if the zero is ten times higher the Gain-Bandwidth (GB), then in order to achieve a 60° phase margin, the second pole must be placed at least 2.2 times higher than GB. Make any reasonable assumption. **(20)**

(b) Draw the schematic diagram of a bi-directional I/O pad and explain the operation of the circuit. What is the usual size of the pad in a 100 nm process? What precautions are taken against latch-up and ESD in an I/O pad? **(15)**

L-4/T-2/EEE

Date : 20/11/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 437** (Digital Communication)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

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SECTION – A

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

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1. (a) Show that the entropy of the n-th extension X^n of a memory less source X is $H(X^n) = nH(X)$. Consider a memoryless source X with alphabet $X = \{a_1, a_2, a_3\}$ and associated probability distribution $\{P(a_1), P(a_2), P(a_3)\}$ $= \{\frac{1}{2}, \frac{1}{4}, \frac{1}{4}\}$. The probabilities of the elementary messages of the second extension of the source are shown below. Compare the entropy of the source and its second extension. **(15)**

Message of X^2	b_1	b_2	b_3	b_4	b_5	b_6	b_7	b_8	b_9
Message of X	a_1a_1	a_1a_2	a_1a_3	a_2a_1	a_2a_2	a_2a_3	a_3a_1	a_3a_2	a_3a_3
$P(b_j)$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{16}$

(b) Explain the term prefix code with an example. **(5)**

(c) Consider a random variable X taking values in the set x = {1, 2, 3, 4, 5} with probabilities 0.25, 0.25, 0.2, 0.15, 0.15, respectively. Determine the code words for the symbols using Huffman algorithm. Comment on the amount of data compression achieved. **(15)**

2. (a) Establish the decision rule **(20)**

$$(r_1 - S_{11})^2 + (r_2 - S_{12})^2 \underset{0_D}{\overset{1_D}{\gtrless}} (r_1 - S_{21})^2 + (r_2 - S_{22})^2$$

for binary data transmission. Also, draw the block diagram of the correlation receiver to implement the decision rule and explain how the receiver can be implemented using a matched filter.

(b) Determine the basis function for the signal set given in Fig. for Q. 2(b). Show the decision region for $P_1 = 0.25$ and $P_2 = 0.75$. **(15)**

Contd P/2

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Contd Q. No. 2(b)

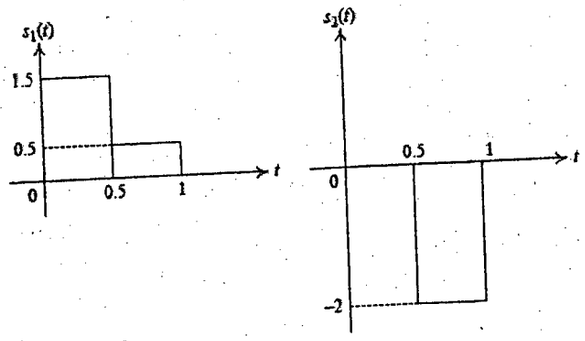

Fig. for Q. No. 2(b)

3. (a) Design a (5, 3) block coder using the following mapping: **(10)**

Input Sequence	Coded Sequence
000	00000
001	10101
010	01011
011	10111
100	11010
101	10000
110	10100
111	11001

(b) Consider the (6, 3) linear block code described by the generator matrix given by **(15)**

$$G = \begin{bmatrix} 1 & 1 & 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 \end{bmatrix}$$

Determine an input and output table for this encoder and its error detection and correction capabilities. Find its parity, check matrix and the syndrome table. Also, explain how this encoder corrects the error e = (000100).

(c) Explain (i) soft and hard decoding and (ii) full and lower complexity of Viterbi algorithm. **(10)**

4. (a) Draw the signal-space plot for the signal sets given by **(15)**

$$S_i(t) = V_i\sqrt{\frac{2}{T_s}}\cos(2\pi f_c t);\ 0 \le t \le T_s \ \text{i} = 1, 2, \ldots 8;\ f_c = k/T_s \ \text{k is an integer.}$$

(b) Consider a convolutional coder with n = 3, k = 1, k = 3. The connection representation is given by g_1 = (1 0 1), g_2 = (1 1 1) and g_3 = (1 1 1). Describe the coder using a trellis diagram. Calculate d_{free} for this coder. **(10)**

(c) Perform set partitioning of a 16-QAM signal. The constellation diagram for the signal is shown in Fig. for Q. 4(c). **(10)**

Contd P/3

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Contd Q. No. 4(c)

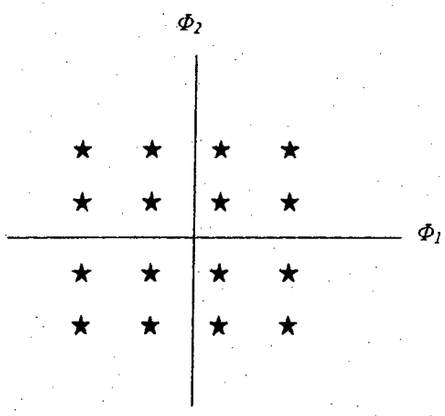


Fig. for Q. No. 4(c)

SECTION – B

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

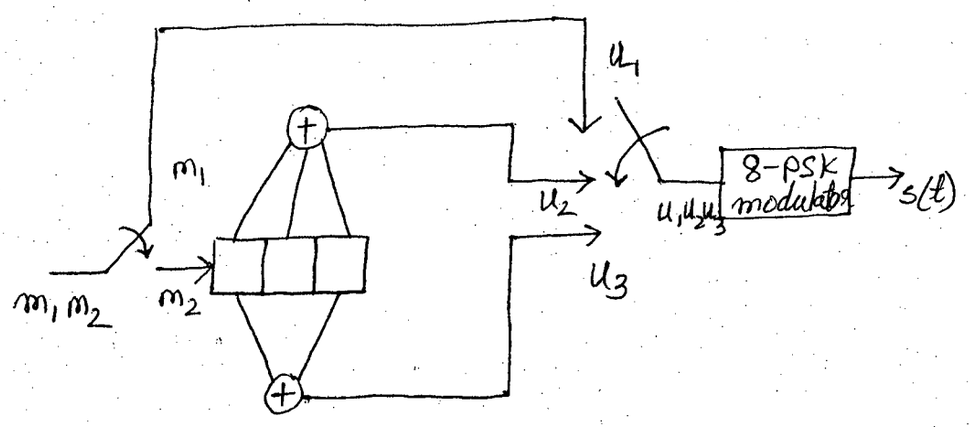
Question No. 5 is compulsory.

5. (a) Define digital communication. Write down its advantages over analog communication. Draw the basic block diagram of digital communication system. What is the range of frequency for satellite communication? **(10)**

(b) Explain very briefly random variable, stochastic process and random process. State Bayes theorem. **(15)**

(c) Two statistically independent random variables X and Y have mean values $\overline{X} = 2$ and $\overline{Y} = 4$, respectively. They have second moments $\overline{X^2} = 2$ and $\overline{Y^2} = 4$, respectively. Find the variance and second moment of the random variable W = 3X – Y. **(10)**

6. Figure for Q. No. 6 shows a TCM Coder and constellation diagram for 8-PSK modulation. If the input to the TCM decoder is [(0.7, 0) (1.2, 0) (3.3, 0) (1.2, 0)], determine the output of the decoder. [Use Viterbi algorithm]. **(35)**



TCM coder

Contd P/4

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Contd Q. No. 6

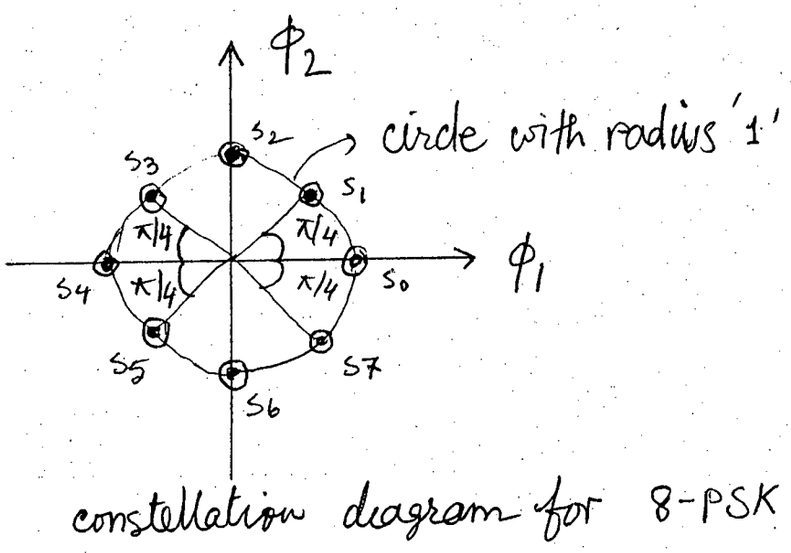

Fig. for Q. No. 6

7. (a) What is meant by line coding? What are the desirable properties of a line Code? **(10)**

   (b) Draw the NRZ, RZ, Bipolar-AMI, HDB3 and B8ZS waveforms for the binary bit stream 1100000000110000010. Also draw the PSD of each waveforms. **(25)**

8. (a) Deduce the following- **(15)**

$$P(\text{error}) = Q\left(\frac{\text{distance between the signals}}{2 \times \text{noise RMS value}}\right)$$

   (b) Explain very briefly BASK scheme and compute $P(\text{error})$ for this. **(20)**

L-4/T-2/EEE Date : ~~18/12/2012~~

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 439** (Mobile Cellular Communication)

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) Consider a cellular system in which there are a total of 312 channels available for handling traffic. Suppose the area of a cell is 3 km^2 and the area of the entire system is 900 km^2. The cluster size of the system is taken to be 7 and the path loss exponent of the medium is found to be 3. **(18)**

   (i) Calculate (a) system capacity and (b) worst case signal to interference ratio under hexagonal cellular system modeling considering only the nearest co-channel interference.

   (ii) Solve (i) if cluster size is 9 instead of 7 and comment on the results.

   (b) When is the cell splitting necessary in a cellular system? Show that cell splitting increases the system capacity n^2 times and reduces the total power consumption $n^{\eta-2}$ times where η is the path loss exponent of the medium and n is the ratio of the radii of cells before and after cell splitting. **(17)**

2. Assume that a cellular system is modeled by square cells. The rule for finding the nearest co-channel cells: move i cells along the diagonals in both directions. The radius of each square, i.e., the distance between the centre and vertex is R. Show that **(35)**

   (i) the cluster size, $N = 2i^2$.

   (ii) the distance between the centres of two co-channel cells, $D = \sqrt{2N}\ R$.

   (iii) Worst case signal to interference ratio considering interference only from the nearest co-channel cells, $\frac{S}{I} = \frac{1}{4}\left(\sqrt{2N}\right)^{\eta}$ where η is the path loss exponent of the medium.

   (iv) Compare hexagonal cell modeling and square cell modeling on the following aspects.

   (a) The number of base transceiver systems (BTSs) required to cover system area if R remains the same.

   (b) the frequency reuse ratio and worst case signal to interference ratio if cluster size remains the same.

Contd P/2

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3. (a) Write down the comparative advantages and disadvantages between signal strength and signal to interference ratio based handoff techniques. **(6)**

(b) Show that the dropping call rate for interference limited cellular system can be approximated as $R = \sum_{n=1}^{N} \alpha_n \left[1 - (1-\mu)^n\right]$ where the symbols have their usual meanings. **(12)**

(c) Assume that a two-cell cellular system uses delaying a hand off, i.e., two-handoff level algorithm. The two received signal strength (RSS) levels are - 60 dBm and - 70 dBm. The locations of the base transceiver systems BTS_1 and BTS_2 of the cells are (0, 0) and (1000,0), respectively. The initial position of a mobile station (MS) is (100,0) at time t = 0 which is connected to BTS_1 and is moving toward the BTS_2 with a constant speed of 10 m/s. Assume, log-normal path loss model with path loss exponent of 3 and far field cross over distance of 1 m. Determine (i) When handoff will be initiated? (ii) When handoff will occur? (iii) How many times the handoff requests need to be sent? Assume that the BTSs and the MS transmit signals with a power of 64 mW. The antenna gain is assumed to be 0 dB. **(17)**

4. (a) Show that the diversity gain for M branches selection diversity technique is $\sum_{k=1}^{M} \frac{1}{k}$. **(17)**

(b) Assume that a communication system is using maximal ratio combining diversity technique with two branches. Before amplification, the average signal to noise ratio (SNR) at each branch is found to be 12 dB. The required SNR for the system is 9.6 dB. Determine the (i) SNR, (ii) diversity gain and (iii) outrage probability of the system. What will be the outrage probability if any diversity technique is not used? **(18)**

SECTION – B

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

5. (a) Briefly describe the factors affecting the small scale fading. Determine the fading characteristics of a channel considering LOS scattering. **(15)**

(b) State the log-distance path loss model for real environment including shadowing effect. Find the cell coverage considering this path loss model without shadowing for the condition that, at the cell boundary the path loss will not be 6 dB larger than that at the reference distance of 1 km. (consider free space environment) **(10)**

(c) Explain the two-ray propagation model over flat plane for mobile radio environment. **(10)**

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6. (a) Define frequency management and channel assignment for mobile cellular network. Show the spectrum allocation for AMPS system. **(10)**

   (b) With proper example, explain the fixed channel assignment for omnidirectional-antenna and directional antenna cells. **(8)**

   (c) What are the different types of antenna used for cell sites and mobile stations? Differentiate between isotropic antenna and omnidiractional antenna with necessary figures. **(17)**

   Show the directional antenna arrangement for 120° sector and 60° sector. Assume 4-cell pattern or 7-cell pattern for total 333 radio channels.

7. (a) Write the relative merits and demerits of multiple access techniques namely FDMA, TDMA and CDMA used for mobile wireless cellular systems. Why they are called conflict free multiple access methods? **(12)**

   (b) Describe the DS-SS CDMA system with necessary diagrams. **(14)**

   (c) Summarize the characteristics of DS-SS CDMA based mobile cellular system. **(9)**

8. (a) Draw the typical functional architecture of GSM cellular network.
   Comment on the following key features of GSM technology: (i) Digital modulation, (ii) GSM channel and (iii) Channel coding. **(15)**

   (b) Why interleaving is used? Explain the interleaving technique used in GSM system. **(10)**

   (c) Discuss the mobility management adopted in GSM system. **(10)**

L-4/T-2/EEE **Date : 01/01/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 423** (Numerical Methods)

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) Solve the following tridiagonal system using Thomas algorithm: **(17)**

$$\begin{bmatrix} 2 & -1 & 0 & 0 \\ -1 & 2 & -1 & 0 \\ 0 & -1 & 2 & -1 \\ 0 & 0 & -1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix} = \begin{bmatrix} 40 \\ 0 \\ 0 \\ 200 \end{bmatrix}$$

(b) Perform LU factorization of the following symmetric matrix using Cholesky decomposition: **(14)**

$$A = \begin{bmatrix} 6 & 15 & 55 \\ 15 & 55 & 225 \\ 55 & 225 & 979 \end{bmatrix}$$

(c) Define norm of a matrix. Also state the convergence criterion of Gauss-Seidel iterative method. **(4)**

2. (a) Perform the following integration numerically using Gauss quadrature (two point Gauss-Legendre Formula): **(12)**

$$I = \int_0^2 xe^x \, dx$$

(b) Use Romberg integration scheme to approximate the following integral:

$$I = \int_0^{\pi} \sin x \, dx$$

Use trapezoidal rule to perform the first step. Show five calculation steps (n = 5). **(12)**

(c) Explain how a double integration can be performed using matrix multiplications. Consider that composite trapezoidal rule is used for approximating the integrals. **(11)**

3. (a) Solve the following Neumann boundary value problem using finite difference method: **(17)**

$$\frac{d^2u}{dx^2} - u = 0, \quad u'(1) = 1, \quad u'(2.5) = 8$$

Use step size, h = 0.5. Write the answers in tabular form.

(b) Solve the following Dirichlet boundary value problem using finite element method: **(18)**

$$\frac{d^2y}{dx^2} + 10 = 0, \quad y(0) = 40, \quad y(6) = 200$$

Use equal size elements of length 2. Write the answers in tabular form.

Contd P/2

EEE 423

4. (a) State Gerschgorin's circle theorem. Use this theorem to estimate the position of the Eigen values in the complex plane for the following matrix: **(8)**

$$A=\begin{bmatrix} 4 & 1 & 1 \\ 0 & 2 & 1 \\ -2 & 0 & 9 \end{bmatrix}.$$

(b) Use Householder's method to convert the following matrix in tridiagonal form: **(14)**

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

(c) Briefly discuss the purpose of matrix triangulatization in cases of Eigen value calculation. What requirements are enforced on the triangularization procedure? **(5)**

(d) (b) Use power method to approximate the largest Eigen value of the following matrix: **(8)**

$$A=\begin{bmatrix} 8 & 0 & 1 \\ 1 & 12 & 0 \\ 0 & 2 & 6 \end{bmatrix}$$

Show three iterations.

SECTION – B

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

5. (a) Consider the following data table: **(18)**

x_i	1.0	1.3	1.6	1.9
$f(x_i)$	0.7651977	0.6200860	0.4554022	0.2818186

Approximate the value of $f(1.5)$ using Newton's divided difference interpolation formula. If an additional data point (2.2, 0.1103623) is introduced, what will be the new approximate of $f(1.5)$?

(b) Perform polynomial curve fitting to generate a quadratic equation for the following data points: **(17)**

x	0	1	2	3	4
y	2	0	–8	–22	–42

6. (a) Use Richardson Extrapolation technique to show that an approximate expression of first derivative is given by: $f'(x)=\frac{4}{3}D\left(\frac{h}{2}\right)-\frac{1}{3}D(h)$. Also show that this approximate has an error in order of $O(h^4)$. **(14)**

Contd P/3

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Contd. Q. No. 6

(b) Use composite trapezoidal rule to evaluate the integral: $\int_0^4 y\,dx$, where x and y are the data points given in question 5(b). Use $h = 1$. Repeat the calculations using composite Simpson's 1/3 rule. **(11)**

(c) Show that the Newton-Raphson method for solving nonlinear equations is quadratically convergent. **(10)**

7. (a) Derive the equations for second order RK method. **(17)**

(b) Solve the following ODE from $x = 0$ to $x = 0.5$ using fourth order RK method: **(13)**

$$\frac{dy}{dx} = f(x, y) = 4e^{4x/5} - \frac{y}{2}$$

Use initial condition of $y(0) = 2$ and step size, $h = 0.5$.

(c) Suppose bisection method is being used to solve a nonlinear equation. The initial two guesses are 3 and 7. If a single root exists within this range and it is required to find the root with absolute error limit of 10^{-6}, then calculate how many iterations are required. **(5)**

8. (a) Solve the following second order initial value problem from $x = 0$ to $x = 1$ using Euler's method: **(14)**

$$\frac{d^2y}{dx^2} + 4e^x = 2.$$

The initial conditions are given as: $y(0) = 1$, $\left.\frac{dy}{dx}\right|_{x=0} = -2$. Use step size, $h = 0.5$.

(b) Consider the following equation: **(12)**

$$f(x) = 3x + \sin x - e^x = 0.$$

Find the root of the above equation using False-position method with initial guesses of 0 and 1. Perform 5 iterations.

(c) Show that fixed point iteration method is linearly convergent. From the analysis, comment on the condition of convergence. **(9)**

26.12.12

L-4/T-2/EEE **Date : 26/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 441** (Telecommunication Engineering)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

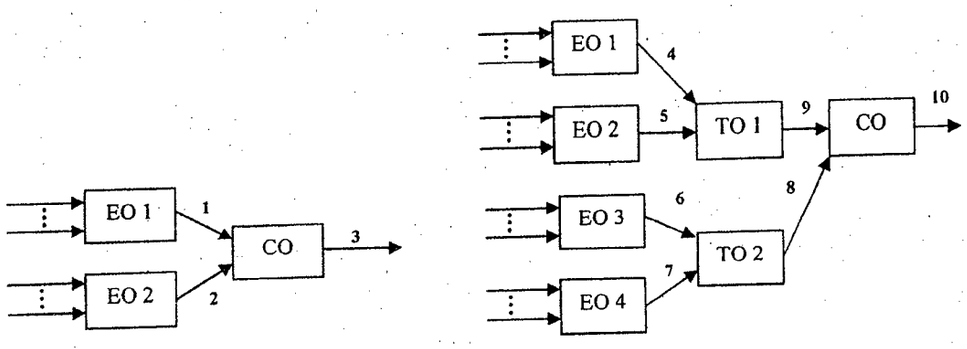
There are **FOUR** questions in this section. Answer any **THREE**.

Erlang B traffic table is attached with the question.

1. (a) Derive the first Erlang distribution for a lost-call system. From the distribution, show that the following iterative relation is true: **(12)**

$$E_{1,N}(A)=\frac{AE_{1,N-1}(A)}{N+AE_{1,N-1}(A)}$$

(b) Consider the networks shown in Figure 1(b). In both networks, a total of 400 users exist and they are equally distributed among the end offices (EO). Assume that the users are active 6% of the time. For a 2% blocking probability, calculate the number of circuits required at each of the trunk lines (labeled 1 to 10). Show the answers in tabular format. If the user activity increases to 12% and the number of circuits remain unchanged, what will be the new blocking probabilities of the two networks? Which network is more immune to blocking? **(16)**



Network 1 Network 2

Figure 1(b)

(c) What is the blocking probability of a PBX central office trunk group with 10 circuits servicing a first-attempt offered traffic load of 7 Erlangs? Consider the system to be a lost-calls-returning system. Perform 5 iterations. Also calculate carried traffic and overflow traffic. **(7)**

Contd P/2

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2. (a) Derive the second Erlang distribution for a queuing system. Also find the expression of probability of delay. **(17)**

(b) Consider the network shown in Figure 2(b), which employs a lost-calls-cleared system. A subscriber under the end-office 'P' is trying to connect to a subscriber under the end-office 'S'. Calculate the end-to-end blocking probability for such a case. Assume that the traffic from P is first directed towards S. In case of the direct path being busy, the traffic is routed from P to Q to S. In case of the path from Q to S being busy, the traffic is re-routed to the path P to Q to R to S. The end-offices Q and R have their own traffic sources. The offered traffic and number of circuits at each trunk group is denoted in Figure 2(b). **(18)**

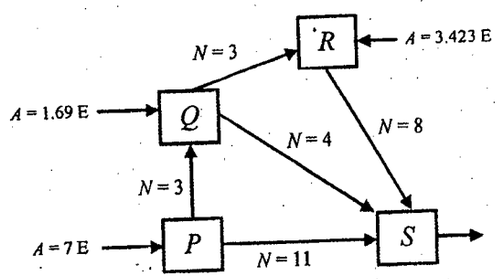

Figure 2(b)

3. (a) Determine the condition for a three stage space division switch to be strictly non-blocking. Derive the expression for minimum number of cross-points in such a switch. Also calculate the total number of inter-connecting lines required for that switch. **(14)**

(b) Draw the block diagram of a Space-Time-Space (STS) switch. Derive the expression of system complexity of a STS switch. Show detailed calculations. **(14)**

(c) Show that, for a digital time division switching, the number of channels per frame that can be switched is related to memory access time. **(7)**

4. (a) The generator polynomial of a (7, 4) Hamming code is $g(x) = x^3 + x^2 + 1$. Find the code words for all possible data words and show the results in tabular form. Also create a table containing all possible error patterns (with only 1 bit error), and corresponding syndromes. Use these tables to find the correct data word when the received code word is: **(22)**

(i) 0001101, (ii) 1110011, and, (iii) 1011001.

(b) Calculate the bit rate of a T1 channel and an E1 channel. **(5)**

(c) A voice signal has a bandwidth of 4 kHz. The signal is sampled at Nyquist rate and digitized using 8 bit PCM. The digital signal is modulated by a 120 kHz carrier (ASK modulation scheme) and transmitted over a pair of copper wires. Find the bandwidth requirement of the wires. **(8)**

Contd P/3

EEE 441

SECTION – B

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

5. (a) Discuss the principle of FDMA and find the expression of the spectral efficiency of a FDMA cellular communication system. **(17)**

In AMPS cellular system, the one-way system bandwidth is 12.5 MHz with channel bandwidth of 30 KHz with guard band at each end of 20 KHz. The frequency reuse factor is 7 and the total coverage area of a cluster is 20 km^2. The number of control channel is 42 and the traffic efficiency of a channel is 0.8 erlang. Determine:

(i) Spectral efficiency in channels/MHz-km^2;

(ii) Spectral efficiency in Erlangs/MHz-km^2;

(iii) No. of channels available per cell.

(b) Distinguish between DS-CDMA and FH-CDMA using appropriate diagrams. Draw the block diagram of a DS-CDMA transmitter and receiver and derive the expression of carrier to interference plus noise ratio. Under what conditions interference may be reduced to zero? **(18)**

6. (a) Define the following parameters: **(15)**

(i) Frequency reuse factor

(ii) Frequency reuse distance

(iii) Co-channel interference

Show that the carrier to co-channel interference ratio (CCIR) in a hexagonal cellular system is given by $\text{CCIR} = \frac{1}{6}(D/R)^{\gamma}$ for interference from first-tier cells.

(b) Discuss the methods of reducing the CCI in a cellular communication system. **(10)**

(c) In cellular communication system the minimum required CCIR is 27 dB for $\gamma = 3.5$. Determine the required value of number of cells per cluster. If the cell radius is 6 km, determine the reuse distance. **(10)**

7. (a) Define antenna aperture and antenna gain and find their relationship. What is G/T ratio and Noise Figure? From the noise model of a simplified super-heterodyne satellite receiver, find the expression of system noise temperature. **(15)**

Contd P/4

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Contd Q. No. 7

(b) A Ku-band satellite system has the following specifications: **(20)**

TX Earth Station parameters:

Antenna diameter = 6 m

Antenna aperture efficiency = 0.65

Minimum Required C/N in Ku-band transponder = 30 dB

Misc. uplink loss = 0.5 dB

Location: –3 dB contour of satellite receiving antenna.

RX Earth Station parameters:

Receiver IF noise bandwidth = 43 MHz

Antenna gain = 20 dB

Antenna noise temperature = 30 deg. K

LNA noise temperature = 120 deg. K

Required overall C/N = 18 dB

Misc. downlink loss = 2.0 dB

Satellite Parameters:

Antenna gain = 30 dB

Receive system noise temperature = 500 deg K

Transponder bandwidth = 54 MHz

Signal: Compressed digital signal with transmitted symbol rate of 43 MSps.

If the power transmitted by the transmitting earth station is 800 W, determine:

(i) EIRP in dBW of the transmitting station;

(ii) C/N for uplink

(iii) C/N for downlink.

8. Write notes on (any three of the following): **(35)**

(i) SDH/SONET,

(ii) ADSL/VDSL,

(iii) ISDN,

(iv) ARQ Schemes.

Contd P/5

Erlang B Traffic Table

Maximum Offered Load Versus B and N
B is in %

N/B	0.01	0.05	0.1	0.5	1.0	2	5	10	15	20	30	40
1	.0001	.0005	.0010	.0050	.0101	.0204	.0526	.1111	.1765	.2500	.4286	.6667
2	.0142	.0321	.0458	.1054	.1526	.2235	.3813	.5954	.7962	1.000	1.449	2.000
3	.0868	.1517	.1938	.3490	.4555	.6022	.8994	1.271	1.603	1.930	2.633	3.480
4	.2347	.3624	.4393	.7012	.8694	1.092	1.525	2.045	2.501	2.945	3.891	5.021
5	.4520	.6486	.7621	1.132	1.361	1.657	2.219	2.881	3.454	4.010	5.189	6.596
6	.7282	.9957	1.146	1.622	1.909	2.276	2.960	3.758	4.445	5.109	6.514	8.191
7	1.054	1.392	1.579	2.158	2.501	2.935	3.738	4.666	5.461	6.230	7.856	9.800
8	1.422	1.830	2.051	2.730	3.128	3.627	4.543	5.597	6.498	7.369	9.213	11.42
9	1.826	2.302	2.558	3.333	3.783	4.345	5.370	6.546	7.551	8.522	10.58	13.05
10	2.260	2.803	3.092	3.961	4.461	5.084	6.216	7.511	8.616	9.685	11.95	14.68
11	2.722	3.329	3.651	4.610	5.160	5.842	7.076	8.487	9.691	10.86	13.33	16.31
12	3.207	3.878	4.231	5.279	5.876	6.615	7.950	9.474	10.78	12.04	14.72	17.95
13	3.713	4.447	4.831	5.964	6.607	7.402	8.835	10.47	11.87	13.22	16.11	19.60
14	4.239	5.032	5.446	6.663	7.352	8.200	9.730	11.47	12.97	14.41	17.50	21.24
15	4.781	5.634	6.077	7.376	8.108	9.010	10.63	12.48	14.07	15.61	18.90	22.89
16	5.339	6.250	6.722	8.100	8.875	9.828	11.54	13.50	15.18	16.81	20.30	24.54
17	5.911	6.878	7.378	8.834	9.652	10.66	12.46	14.52	16.29	18.01	21.70	26.19
18	6.496	7.519	8.046	9.578	10.44	11.49	13.39	15.55	17.41	19.22	23.10	27.84
19	7.093	8.170	8.724	10.33	11.23	12.33	14.32	16.58	18.53	20.42	24.51	29.50
20	7.701	8.831	9.412	11.09	12.03	13.18	15.25	17.61	19.65	21.64	25.92	31.15
21	8.319	9.501	10.11	11.86	12.84	14.04	16.19	18.65	20.77	22.85	27.33	32.81
22	8.946	10.18	10.81	12.64	13.65	14.90	17.13	19.69	21.90	24.06	28.74	34.46
23	9.583	10.87	11.52	13.42	14.47	15.76	18.08	20.74	23.03	25.28	30.15	36.12
24	10.23	11.56	12.24	14.20	15.30	16.63	19.03	21.78	24.16	26.50	31.56	37.78
25	10.88	12.26	12.97	15.00	16.13	17.51	19.99	22.83	25.30	27.72	32.97	39.44
26	11.54	12.97	13.70	15.80	16.96	18.38	20.94	23.89	26.43	28.94	34.39	41.10
27	12.21	13.69	14.44	16.60	17.80	19.27	21.90	24.94	27.57	30.16	35.80	42.76
28	12.88	14.41	15.18	17.41	18.64	20.15	22.87	26.00	28.71	31.39	37.21	44.41
29	13.56	15.13	15.93	18.22	19.49	21.04	23.83	27.05	29.85	32.61	38.63	46.07
30	14.25	15.86	16.68	19.03	20.34	21.93	24.80	28.11	31.00	33.84	40.05	47.74
31	14.94	16.60	17.44	19.85	21.19	22.83	25.77	29.17	32.14	35.07	41.46	49.40
32	15.63	17.34	18.21	20.68	22.05	23.73	26.75	30.24	33.28	36.30	42.88	51.06
33	16.34	18.09	18.97	21.51	22.91	24.63	27.72	31.30	34.43	37.52	44.30	52.72
34	17.04	18.84	19.74	22.34	23.77	25.53	28.70	32.37	35.58	38.75	45.72	54.38
35	17.75	19.59	20.52	23.17	24.64	26.44	29.68	33.43	36.72	39.99	47.14	56.04
36	18.47	20.35	21.30	24.01	25.51	27.34	30.66	34.50	37.87	41.22	48.56	57.70
37	19.19	21.11	22.08	24.85	26.38	28.25	31.64	35.57	39.02	42.45	49.98	59.37
38	19.91	21.87	22.86	25.69	27.25	29.17	32.62	36.64	40.17	43.68	51.40	61.03
39	20.64	22.64	23.65	26.53	28.13	30.08	33.61	37.72	41.32	44.91	52.82	62.69
40	21.37	23.41	24.44	27.38	29.01	31.00	34.60	38.79	42.48	46.15	54.24	64.35
41	22.11	24.19	25.24	28.23	29.89	31.92	35.58	39.86	43.63	47.38	55.66	66.02
42	22.85	24.97	26.04	29.09	30.77	32.84	36.57	40.94	44.78	48.62	57.08	67.68
43	23.59	25.75	26.84	29.94	31.66	33.76	37.57	42.01	45.94	49.85	58.50	69.34

L-4/T-2/EEE **Date : 01/01/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 427** (Measurement and Instrumentation)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Design an Ayrton shunt to provide an ammeter with current ranges of 1A, 5A and 10A. A basic meter with an internal resistance of 50 Ω and a full scale deflection current of 1 mA is to be used. **(10)**

   (b) Derive the equations for deflection under both DC and AC operations for an electrodynamometer type instrument. **(15)**

   (c) Show that the deflecting torque in an electrodynamometer type of voltmeter is proportional to square of the rms value of applied voltage irrespective of its waveform. **(10)**

2. (a) Draw the block diagram of a ramp-type digital voltmeter and briefly explain its working principle. **(10)**

   (b) Describe the two ways to extend the voltage range of electrostatic voltmeters. **(10)**

   (c) An electrostatic voltmeter is constructed with six parallel, semi-circular fixed plates equi-spaced at 4 mm intervals and five interleaved semi-circular movable plates that move in planes midway between the fixed plates in air. The instrument is spring controlled. If the radius of movable plates is 40 mm, calculate the spring constant if 10 kV corresponds to full scale deflection of 100°. Neglect fringing edge effects and plate thickness. The permittivity of air is 8.85×10^{-12} F/m. **(15)**

3. (a) Draw the equivalent circuit and phasor diagram for potential transformer. Derive an expression for its ratio and phase angle errors. **(18)**

   (b) A potential transformer rated 6900/115 V, has 22500 turns in the primary winding and 375 turns in the secondary winding. With 6900 V applied to the primary and the secondary circuit open circuited, the primary winding current is 0.005 A, lagging the voltage by 73.7°. With a particular burden connected to the secondary, the primary winding current is 0.0125 A, lagging the voltage by 53.1°. **(17)**

   Primary winding resistance = 1200 Ω
   Primary winding reactance = 2000 Ω
   Secondary winding resistance = 0.4 Ω
   Secondary winding reactance = 0.7 Ω

   (i) Find the secondary current and terminal voltage using the applied primary voltage $V_P = 6900 + j0$ as reference. Find the load burden also.

   (ii) Find the actual transformation ratio and also the phase angle.

Contd P/2

EEE 427

4. (a) Show that the actual reading of an electrodynamometer type wattmeter for lagging load is true power × $(1+\tan\phi\tan\beta)$. **(15)**

(b) How can the error caused by pressure coil inductance of an electrodynamometer type wattmeter be eliminated? **(8)**

(c) The current coil of a wattmeter is connected in series with an ammeter and an inductive load. A voltmeter and the voltage coil are connected across a 100 Hz supply. The ammeter reading is 4.5 A and the voltmeter and wattmeter readings, are respectively, 240 V and 23 W. The inductance of voltage circuit is 10 mH and its resistance is 2000 Ω. If the voltage drops across the ammeter and the current coil are negligible, what is the percentage error in the wattmeter reading? **(12)**

SECTION – B

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

The symbols represent usual meanings.

5. (a) Derive the expression for the total deflecting torque in induction type energy meter. Show that the deflection is maximum when the phase angle between two fluxes is 90° and when the disc is purely resistive. **(18)**

(b) Describe the working principle of a single phase induction type energy meter. **(17)**

6. (a) Define active and passive transducers. Show that the gauge factor of a strain gauge is expressed by $G_f = 1+2\nu+\frac{\Delta P/P}{\varepsilon}$. **(13)**

(b) Explain how linear motion is converted into electrical signal using LVDT. **(10)**

(c) The output of an LVDT is connected to a 5 V voltmeter through an amplifier whose amplification factor is 250. A output of 2 mA appears across the terminals of LVDT when the core moves through a distance of 0.5 mm. Calculate the sensitivity of the LVDT and that of the whole setup. The millivoltmeter scale has 100 divisions. The scale can be read to 1/5 of a division. Calculate the resolution of the instrument in mm. **(12)**

7. (a) A capacitive displacement transducer uses a differential arrangement with two outer plates which are fixed and a central plate which is movable. Show that the sensitivity of such a transducer is constant. **(15)**

(b) A parallel plate capacitive transducer uses plates of area 500 mm^2 which are separated by a distance of 0.2 mm. Calculate the value of capacitance when the dielectric is air having a permittivity of 8.85×10^{-12} F/m. **(20)**

Contd P/3

EEE 427

Contd. Q. No. 7(b)

(i) Calculate the change in capacitance if a linear displacement reduces the distance between the plates to 0.18 mm. Also calculate the ratio of per unit change of capacitance to per unit change of displacement.

(ii) Suppose a mica sheet 0.01 mm thick is inserted in the gap. Calculate the value of original capacitance and change in capacitance for the same displacement. Also calculate the ratio of per unit change in capacitance to per unit change in displacement. The dielectric constant of mica is 8.

8. (a) A piezo-electric quartz crystal has an area of 100 mm^2 and is 1 mm thick. It is held between two metal electrodes and is used for measurement of changes in force across the crystal. Young's modulus for the material is 90 GN/m^2, the charge sensitivity is 2 pC/N, the relative permittivity is 5. **(17)**

The resistivity is 10^{12} Ωm. A 20 pF capacitance and a resistance of 100 MΩ are connected in parallel across the electrodes. If a force $F_i = 0.01 \sin (1000\ t)$ N is applied, find

(i) peak to peak voltage swing across the electrodes under open circuit and under load conditions

(ii) the maximum change in crystal thickness.

[F_i is the instantaneous value of force F].

The permittivity of free space is 8.85 pF/m.

(b) A piezo-electric transducer has a capacitance of 1000 pF and a chanrge sensitivity of 40×10^{-3} C/m. The connecting cable has a capacitance of 300 pF while the oscilloscope used for readout has a readout input resistance of 1 MΩ with a parallel capacitance of 50 pF. **(18)**

(i) What is the sensitivity (V/m) of the transducer alone?

(ii) What is the high frequency sensitivity (V/m) of the entire measuring system?

(iii) What is the lowest frequency that can be measured with 5 percent amplitude error by the entire system?

(iv) What is the value of an external shunt capacitance that can be connected in order to extend the range of 5 percent error down to 10 Hz?

(v) With external capacitance calculated in (iv) connected in the circuit, what is the system high frequency sensitivity?

A. S. M. Sohidull Islam

L-4/T-2/EEE **Date : 26/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 481** (Power System Operation and Control)

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) Discuss thermal system dispatch considering network losses, and develop a relationship of the principle of generation dispatch incorporating the transmission loss. **(17)**

   (b) Consider three generating units supplying to a total of 850 MW of load. The generation cost curves are given by equations, **(18)**

   $F_1 = 561 + 7.92\,P_1 + 0.00156\,P_1^2$ R/h

   $F_2 = 310 + 7.85\,P_2 + 0.00194\,P_2^2$ R/h

   $F_3 = 78 + 7.97\,P_3 + 0.00482\,P_3^2$ R/h

   The network losses can be approximated as, $P_{loss} = 0.00003\,P_1^2 + 0.00009\,P_2^2 + 0.00012\,P_3^2$.

   Dispatch P_1, P_2, P_3 upto two iterations.

   Start with P_1 = 400 MW, P_2 = 300 MW, P_3 = 150 MW.

2. (a) Present the forward dynamic programming approach to the unit commitment problem. **(10)**

   (b) What is the essential difference between economic dispatch and unit commitment? **(10)**

   (c) Consider the generating units: **(15)**

   $F_1(P_1) = 30 + 10\,P_1 + 0.002\,P_1^2 \quad 100 < P_1 < 600$

   $F_2(P_2) = 20 + 8\,P_2 + 0.0025\,P_2^2 \quad 100 < P_2 < 400$

   $F_3(P_3) = 10 + 6\,P_3 + 0.005\,P_3^2 \quad 50 < P_3 < 200$

   Load

t	P_{Load}^t(MW)
1	300
2	500
3	1100
4	400

   No start-up cost, no minimum up-or down-time constraints. Schedule units according to a strict priority order.

Contd P/2

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3. (a) Present the block diagram of two interconnected system area. Include governor, prime mover, rotating mass and load and tie line models. **(17)**

Show that change in tie flow for the system is given by

$$\Delta P_{tie} = \frac{-\Delta P_{L_1}\left(\frac{1}{R_2} + D_2\right)}{\frac{1}{R_1} + \frac{1}{R_2} + D_1 + D_2}$$

(b) Two system areas are connected by a tie line with the following characteristics: **(18)**

Area 1	Area 2
R = 0.01 pu	R = 0.02 pu
D = 0.8 pu	D = 1.0 pu
Base MVA = 500	Base MVA = 500

A load change of 100 MW occurs in area 1. Calculate

(i) the new steady-state frequency

(ii) the change in tie flow

(iii) change in area loads due to frequency drop.

4. (a) Explain how the maximum likelihood method of estimating unknown parameter gives a way to weight the measurements according to their quality. **(16)**

(b) Consider the three bus system shown in figure below having the following characteristics: **(19)**

Meter	Full Scale (MW)	Accuracy (MW)	σ (pu)
M_{12}	100	±6	0.02
M_{13}	100	±3	0.01
M_{32}	100	±0.6	0.002

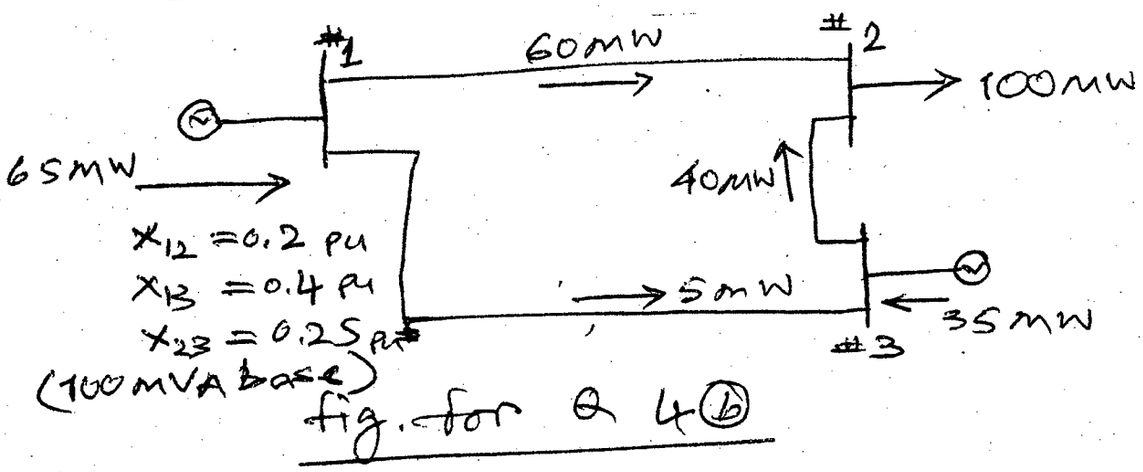

fig. for Q 4(b)

(i) Calculate the best estimate for the phase angle θ_1 and θ_2 given the following measurements:

M_{12} - 60 MW, M_{13} - 4 MW, M_{32} - 40.5 MW

(ii) Calculate the residual J(x)

Contd P/3

EEE 481

SECTION – B

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

All the symbols have their usual meanings.

5. (a) What are the functions of optimal power flow (OPF)? With necessary equations, explain the gradient method of OPF. **(20)**

(b) Explain how the penalty functions are incorporated in Newton's method of OPF. For an AC network model, show that $\Delta h = [J_{hx}][J_{px}]^{-1}[J_{pu}]\Delta u + [J_{hu}]\Delta u$. **(05+10=15)**

6. (a) Minimize the real power losses for the network shown below. **(25)**

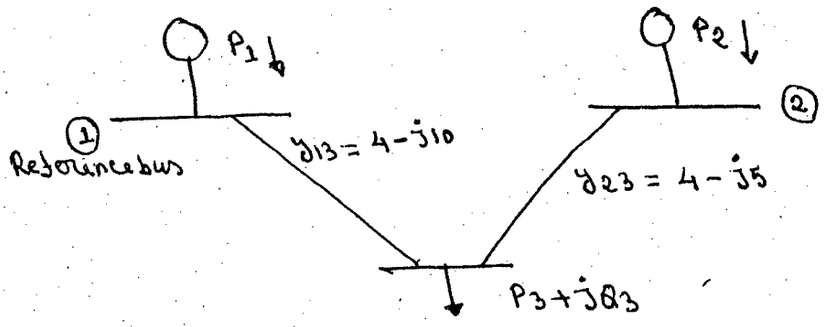

Fig for Q. 6(a)

Given that $P_3 + jQ_3 = (2.0 + j1.0)\,p.u$, $P_2 = 1.7\ p.u$ and $\alpha = 0.03$. Initial voltages, $\begin{bmatrix}|E_1|\\|E_2|\end{bmatrix}^0 = \begin{bmatrix}1.1\\0.9\end{bmatrix} p.u$.

Show one iteration only.

(b) What are the functions of power system security? Briefly explain. **(10)**

7. (a) Explain the terms— (i) Optimal dispatch, (ii) Post contingency, (iii) Secure dispatch and (iv) Secure Post-contingency. **(10)**

(b) Draw the flow chart of contingency analysis using sensitivity factors. **(10)**

(c) With a flow chart, explain 1P1Q contingency selection procedure. **(15)**

8. (a) Explain the bounding technique of contingency analysis. **(15)**

(b) Two generating units, G_1 and G_2, are operating in parallel at 50 Hz to supply a total load of 700 MW. The system configuration is given below: **(10)**

Unit	Rated output (MW)	% speed drop	Loading (MW)
G_1	600	4.0	400
G_2	500	5.0	300

Now if the total load increases by 20%, determine the new loading of each unit and new system frequency before any supplementary control action occurs.

(c) Explain IP algorithm of OPF. **(10)**

L-4/T-2/EEE Date : 18/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 479** (Power System Reliability)

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) Show that the variance of a random variable, x, is given by, $V(x) = E(x^2) - \{E(x)\}^2$. **(5)**

   (b) Two power systems, X and Y, are connected through a tie line of capacity 10 MW. The generation and load data of the two systems are shown below. **(30)**

System	Generation ID	Capacity (MW)	FOR	Peak load (MW)
X	G_1	10	0.2	15
	G_2	30	0.1	
Y	G_3	15	0.1	20
	G_4	25	0.3	

   Using recursive algorithm, determine $LOLP_X$, $LOLP_Y$, $LOLP_{X|Y}$, $LOLP_{Y|X}$, $LOLP_G$.

2. (a) A power system has four generators with the capacities of 100 MW, 200 MW, 300 MW and 400 MW. The FORs of the units are 0.1, 0.2, 0.1 and 0.3, respectively. The system has three load levels of 50 MW, 150 MW and 200 MW with equal probability of occurrence. Using system cumulants, determine the value of normalized random variable, N(z). **(20)**

   (b) A power system has two generators with the capacities of 200 MW and 300 MW. The FORs of the units are 0.02 and 0.03, respectively. The system has two load levels of 250 MW and 300 MW with equal probability of occurrence. Now a new generating unit with the capacity of 400 MW and a FOR of 0.04 is added to the system. Calculate the LCC of the new unit. **(15)**

3. (a) In a large system, the average number of cable faults per year per 200 km length of cable is 0.4. Consider a specified piece of cable with 20 km length. Evaluate the probabilities of 0, 1, 2, and 3 faults occurring in 30 years period. **(10)**

   (b) Two power systems, X and Y, are inter-connected through a tie line with capacity of 10 MW. Generator data and load data of the two systems are given below. **(25)**

   Generator data:

Contd P/2

EEE 479

Contd ... Q. No. 3(b)

System	Unit No.	Capacity (MW)	FoR
X	1	10	0.2
	2	30	0.1
Y	1	10	0.1
	2	20	0.3

Load data:

System	Load (MW)	Probability of occurrence
X	15	0.5
	25	0.5
Y	20	0.5
	25	0.5

Using segmentation method, determine $LOLP_X$, $LOLP_Y$, $LOLP_{XIY}$, $LOLP_{YIX}$ and $LoLP_G$.

4. (a) Derive the general expressions of expected value and standard deviation of a binomial distribution. **(15)**

(b) A power system planner proposes a plan consisting two generating units of capacities 30 MW and 40 MW with FORs of 10% and 20%, respectively. The forecasted Peak demand (L) is Gaussian in nature with the following impulse equation:

$P(L) = 0.3\ \delta(L - 30) + 0.4\ \delta(L - 50) + 0.3\ \delta(L - 70)$, where p(L) = probability of occurrence of L. Evaluate LOLP of the proposed system. **(20)**

SECTION – B

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

5. (a) A power system has the following generator and load model. **(30)**

Generator model:

Generator ID	Capacity (MW)	FOR
G_1	200	0.02
G_2	300	0.03
G_3	400	0.04

Load model:

Load (MW)	Probability of Occurrence
250	0.2
350	0.3
450	0.3
550	0.2

Using recursive technique, determine LOLP of the system.

(b) Compare the segmentation method with cumulant method. **(5)**

Contd P/3

EEE 479

6. (a) A power system has three generators and only three load levels as given below **(20)**

Generator Model

Generator ID	Capacity (MW)	FoR
G_1	200	0.05
G_2	300	0.04
G_3	500	0.03

Load model:

Load (MW)	Probability of Occurrence
300	P_1
400	0.4
1000	P_2

The LOLP of the system is 3.6024%. Determine the value of P_1 and P_2. Use state enumeration technique to solve the problem.

(b) A power system has two generators with the capacities of 20 MW and 30 MW. The FORs of the units are 0.2 and 0.3 respectively. The load duration curve (LDC) of the system is constructed for the period of 50 hours where load is constant at 40 MW for the whole period. Determine LOEP of the system. **(15)**

7. (a) For a Poison distribution, determine (i) the probability of failure occurring zero times in an interval (ii) the probability of failure occurring 'x' times in an interval. **(18)**

(b) Derive the general expression of expected value and standard deviation of Poisson distribution. **(17)**

8. (a) A power system has three generators with capacities of 10 MW, 10 MW and 25 MW. The FORs of the units are 0.2, 0.3 and 0.1, respectively. The system has three load levels of 15 MW, 20 MW and 25 MW, with equal probability of occurrence. Determine LOLP using segmentation method. **(30)**

(b) What are the benefits of interconnection in power systems? **(5)**

L-4/T-2/EEE **Date : 20/11/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 483** (High Voltage Engineering)

Full Marks : 210 Time : 3 Hours

The questions are of equal value.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) With a neat sketch describe briefly the working principle of "Cockcroft-Walton" type multiplier circuit arrangement for generation of HVDC. Find the ripple of this circuit.

   (b) A Cockcroft-Walton type voltage multiplier has eight stages with capacitance, all equal to 0.05 μF. The supply transformer secondary voltage is 125 kV at a frequency of 150 Hz. If the load current to be supplied is 5 mA, find (i) the percentage ripple, (ii) the regulation, and (iii) the optimum number of stages for minimum regulation or voltage drop.

2. (a) Describe erosion breakdown in solid dielectric. Show the current and voltage wave shapes under a.c. voltage.

   (b) A solid dielectric specimen of dielectric constant of 4.0 shown in the figure has an internal void of 1.5 mm. The specimen is 10 mm thick and is subjected to a voltage of 80 kV (r.m.s.). If the void is filled with air and if the breakdown strength of air can be taken as 30 $kV_{(peak)}$/cm, find the voltage at which an internal discharge can occur.

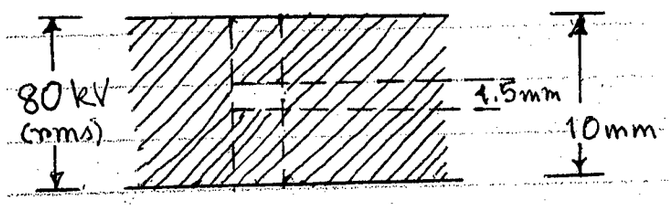

Fig for Q. No. 2(b)

3. (a) Define insulation coordination. With simple diagram describe the statistical method for insulation coordination in a power system.

   (b) Classify insulation according to location and dielectric performance. Explain the correlation between insulation and protection level.

4. (a) Explain the working principle of high voltage "Schering bridge" for measurement of loss tangent and capacitance of a dielectric.

   (b) Describe with a neat sketch the working principle of "Van de Graaff Generator".

Contd P/2

EEE 483

SECTION – B

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

5. (a) What are the different principles of breakdown in insulating liquids? Describe the bubble theory.
   (b)What is streamer mechanism of breakdown in gases? Discuss the mechanism proposed by Loeb and Meck.

6. (a) Describe the negative corona discharge phenomena. Explain the corona power loss for AC lines.
   (b) What is corona onset level? Find the value of ac critical corona onset voltage, E_0, when the air pressure is 120 kPa and the air temperature is 20°C.

7. (a) What are the methods used for high voltage measurements? Explain with a neat diagram the electrostatic voltmeter used for measurement of DC and AC voltages.
   (b) With a neat diagram, explain how a sphere-gap can be used to measure the peak value of high voltage. Describe in detail the parameters and factors that influence such voltage measurement.

8. (a) Explain, with a simple diagram, the general shape of an impulse or transient voltage according to British Standard Specification. With a neat diagram, explain the operation of Marx's multi-stage (six stages) impulse generator.
   (b) How does the lightning occur in nature? With a simple diagram, explain the lightning protection system of a very high rise building.

L-4/T-2/EEE Date : 20/11/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 477** (Power System Protection)

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) What is a protective relay? With a neat diagram briefly describe the use of a protective relay. **(10)**

   (b) An overcurrent relay has an inverse characteristics of **(10)**

$$t = \frac{13.5}{\left(\frac{I}{I_{set}}\right)^{\alpha} - 1}$$

   Where t is the operating time in seconds, I is the line current and I_{set} is the minimum operating current. If I_{set} = 5A and the relay operating time for a CT secondary current of 10A is 2 sec, determine the value of α.

   (c) Derive an expression for the torque generated in an induction type relay. **(15)**

2. (a) What is a directional relay? Draw and explain the characteristics of an ac directional relay. **(15)**

   (b) A directional relay needs a minimum power of 1.5 W to operate. The relay produces maximum torque when the line current leads the line to neutral voltage by an angle of 30°. The line to neutral voltages is $110/\sqrt{3}$ V. The CT ratio is 400 : 5 A. **(20)**

   (i) Draw the operating characteristics.

   (ii) At what lagging or leading loads should the relay not operate even at rated current flow in the forward direction?

3. (a) Why reactance type distance relays need special type of directional unit called starting unit? Derive the characteristics equation of a directional relay to be used along with reactance relays and hence draw and label the operating characteristics for standard 3 zone protection. **(20)**

   (b) With a neat diagram explain the operation of a carrier current relaying scheme for zone protection. **(15)**

4. (a) Why does a synchronous generator need loss of excitation protection? With a suitable diagram explain how to figure out that a synchronous generator has lost excitation. **(15)**

Contd P/2

EEE 477

Contd ... Q. No. 4

(b) A 75 MVA, 132/33 KV, 3-phase star-delta type power transformer is to be given percentage differential protection for internal fault detection. Draw the connection scheme with appropriate labels and give the CT ratios and ratios of the equalizing CT's if needed. You should choose standard CT ratios. **(15)**

(c) What is magnetizing inrush current? How can you avoid this inrush current? **(5)**

SECTION – B

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

5. (a) What is meant by Circuit Breaker (CB) Operating Mechanism? Discuss 3 (three) commonly used CB operating mechanisms. **(15)**

(b) What is transient recovery voltage (TRV)? In what conditions do "Single Frequency" and "Double Frequency" TRV occur? Explain them with necessary circuits and waveforms. **(10)**

(c) Discuss the steps involved in AC arc extinction. **(10)**

6. (a) What are the differences between MCB and MCCB? **(10)**

(b) How does Air Circuit Breakers (ACBs) differ from CBs? **(10)**

(c) How arc is formed in a Vacuum Circuit Breaker (VCB)? Explain the construction and operation of a VCB. **(15)**

7. (a) Why SF_6 gas is an ideal medium for arc extinction? **(5)**

(b) With a neat diagram, explain the construction and operating principle of a single puffer type SF_6 Circuit Breaker. **(25)**

(c) What is a Gas Insulated Substation (GIS)? In what places do GISs are recommended? **(5)**

8. (a) What are the need for Isolators and Earthing Switches in a Power System? **(5)**

(b) What is a DOF? How does it work? **(10)**

(c) How does a "Lightning Arrester" work? Compare the functionalities of "Lightning Arresters" and "Rod-gap Arrestors" **(10)**

(d) What is a Load Break Switch? How does it differ from a Circuit Breaker? **(10)**

L-4/T-2/EEE **Date : 01/01/2013**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 425** (Biomedical Instrumentation)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The questions are of equal value.

Symbols have their usual meanings.

1. (a) Sketch a typical ECG waveform and explain its different components.
   (b) Briefly explain the two phases of a cardiac cycle.

2. (a) Briefly describe the different types of atrio-ventricular blocks with necessary diagrams.
   (b) Explain the following terms: (i) heart murmur, (ii) normal heart sound and (iii) pitch of heart sound.

3. (a) Discuss the following:
   (i) resting heart rate, (ii) recovery heart rate and (iii) instantaneous heart rate.
   (b) Explain the geometric method for the analysis of heart rate variability.

4. (a) What is an EEG signal? Justify why an EEG signal may be used to identify different types of sleep disorders.
   (b) Write short notes on any three of the following:
   (i) Mean arterial pressure
   (ii) Korotkoff sound
   (iii) Sphygmomanometer
   (iv) Direct Measurement of BP.

SECTION – B

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

The figures in the margin indicate full marks.

5. (a) Describe the following terms: **(18)**
   (i) Index of refraction
   (ii) B-scan mode of ultrasonography
   (iii) ESPA Transducer

Contd P/2

EEE 425

Contd. Q. No. 5

(b) Answer the following questions:

(i) Why are Hydrogen nuclei most suitable for MRI? Why is Larmor frequency crucial to MRI? What happens when the RF pulse at the Larmor frequency applied? **(05)**

(ii) Describe the key points of MRI instrumentation. **(12)**

6. (a) Briefly describe Aperture impedance blood cell counter. **(17)**

(b) Give an overview of different types of clinical instrumentation. **(10)**

(c) Draw and explain the simplified schematic of a spectrophotometer. **(08)**

7. (a) Compare power line noise, electrode contact noise and electrosurgical noise based on their typical parameters and characteristics. **(15)**

(b) Write down the basics of Impedance Cardiography. **(20)**

8. (a) Write down the equation that Cole-Cole plot obeys. Derive the Cole-Cole system for practical measurements. **(10)**

(b) Describe major usage of X-Ray. Explain absorption and scattering of X-rays. **(17)**

(c) Describe: **(08)**

(i) Lead Collimating Plates

(ii) Scatter Radiation Grid

Ayon Sen

L-4/T-2/EEE **Date : 26/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 461** (Semiconductor Device Theory)

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) What happens to the initial energy and momentum of an electron after it is scattered due to a perturbation? **(7)**

   (b) Write the expression for the probability of finding an electron in the final state after a perturbation is applied to the system. Discuss different terms in it and explain how the probability changes with time. **(10)**

   (c) Comment on the relative significance of electron-phonon and electron-impurity scattering at different temperatures. Why electron scattering due to longitudinal acoustic phonon can be approximated as quasi-elastic? **(12)**

2. (a) What is "selection rule" for optical transitions? How the selection rule is applied in designing lasers and detectors? Discuss. **(12)**

   (b) Derive an expression for the net exchange of energy due to interaction between electron and photon. Explain the significance of different terms in the expression. **(17)**

   (c) How the electron-photon transition strength can be manipulated? **(6)**

3. (a) Discuss how the mobility of GaAs is affected due to inter-valley electron transport when the applied electric field increases. **(8)**

   (b) Derive an expression for the transmission coefficient of the flux of electrons when freely moving electrons hit a potential barrier. Discuss what happens when the electron energy is greater or less than the potential barrier energy. **(14)**

   (c) Draw the transmission vs. energy of electron flux through a finitely thick potential barrier. Discuss how the tunneling through the barrier can be increased. Also discuss how electrons can be reflected significantly even if the electrons have energy greater than that of the potential barrier. **(13)**

Contd P/2

EEE 461

4. (a) Derive an expression for current when a voltage is applied across a potential barrier and show that the current is not simply proportional to the applied voltage. **(12)**

(b) What happens to the current-voltage relation of a potential barrier when the applied bias is small? **(8)**

(c) What is the condition for resonant tunneling? Discuss. How a resonant tunneling diode should be designed to ensure maximum current? **(15)**

SECTION – B

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

5. (a) What is dispersion? **(5)**

(b) Show that for a 1-D monatomic lattice the system works as a low pass filter. **(15)**

(c) For a 1-D monatomic lattice with N-atoms find the expression of density of states. **(15)**

6. (a) Find the dispersion relation for a linear diatomic lattice. **(18)**

(b) What is Reststrahlen effect? What is the use of this effect? **(8)**

(c) The mass of Na is 23 amu and that of Cl is 35.5 amu. The transverse force constant for NaCl is 10.28 N/m. Find the Reststrahlen wavelength in NaCl. **(9)**

7. (a) Why classical theory of specific heat fails at low temperature? **(8)**

(b) Based on the Debye theory derive the expression of specific heat at very low temperature. **(20)**

(c) What is phonons? **(7)**

8. (a) Considering an electron in vacuum under an external electric field derive the expression of effective mass. **(8)**

(b) Why a completely filled band can contribute no net current in the presence of an external electric field? **(7)**

(c) Using the Tight Binding Model derive the E-k relation near the bottom of the band for a system having a large number of atoms. **(20)**

Ayon Sen

L-4/T-2/EEE **Date : 26/12/2012**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 461** (Semiconductor Device Theory)

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**.

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   (c) Comment on the relative significance of electron-phonon and electron-impurity scattering at different temperatures. Why electron scattering due to longitudinal acoustic phonon can be approximated as quasi-elastic? **(12)**

2. (a) What is "selection rule" for optical transitions? How the selection rule is applied in designing lasers and detectors? Discuss. **(12)**

   (b) Derive an expression for the net exchange of energy due to interaction between electron and photon. Explain the significance of different terms in the expression. **(17)**

   (c) How the electron-photon transition strength can be manipulated? **(6)**

3. (a) Discuss how the mobility of GaAs is affected due to inter-valley electron transport when the applied electric field increases. **(8)**

   (b) Derive an expression for the transmission coefficient of the flux of electrons when freely moving electrons hit a potential barrier. Discuss what happens when the electron energy is greater or less than the potential barrier energy. **(14)**

   (c) Draw the transmission vs. energy of electron flux through a finitely thick potential barrier. Discuss how the tunneling through the barrier can be increased. Also discuss how electrons can be reflected significantly even if the electrons have energy greater than that of the potential barrier. **(13)**

Contd P/2

EEE 461

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(b) What happens to the current-voltage relation of a potential barrier when the applied bias is small? **(8)**

(c) What is the condition for resonant tunneling? Discuss. How a resonant tunneling diode should be designed to ensure maximum current? **(15)**

SECTION – B

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

5. (a) What is dispersion? **(5)**

(b) Show that for a 1-D monatomic lattice the system works as a low pass filter. **(15)**

(c) For a 1-D monatomic lattice with N-atoms find the expression of density of states. **(15)**

6. (a) Find the dispersion relation for a linear diatomic lattice. **(18)**

(b) What is Reststrahlen effect? What is the use of this effect? **(8)**

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8. (a) Considering an electron in vacuum under an external electric field derive the expression of effective mass. **(8)**

(b) Why a completely filled band can contribute no net current in the presence of an external electric field? **(7)**

(c) Using the Tight Binding Model derive the E-k relation near the bottom of the band for a system having a large number of atoms. **(20)**

L-4/T-2/EEE Date : 20/11/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **CSE 451** (Computer Networks)

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) Why is bit stuffing required when special flag bytes are used to recognize frame boundaries? A sender wants to transmit the bit string, 100010000010000001 at the data link layer. The special bit pattern to be used as flag byte is: 10000001. What is the bit string actually transmitted after bit stuffing? Underline the stuffed bits in the resulting bit string. **(3+8=11)**

   (b) A 12-bit Hamming code whose hexadecimal value is 0xE4F arrives at a receiver. What was the original value in hexadecimal? Assume that not more than 1 bit is in error. Show detailed calculation steps. **(12)**

   (c) In the sliding window protocol using selective repeat, the maximum window size is (2^{n-1}) where 'n' is the number of bits used for sequence numbers. Justify this restriction on the maximum window size with a suitable scenario. **(12)**

2. (a) Write down the algorithms for the following two MAC protocols: (i) Slotted Aloha, (ii) p-persistent CSMA. Which of these two have better channel utilization under heavy load? Explain. **(5+5=10)**

   (b) Explain the reason behind having a minimum length for Ethernet frames. Illustrate how this length is determined for 10 Mbps Ethernet. **(8+4=12)**

   (c) Why may switches need to run 'Spanning Tree Protocols'? Explain with an example scenario. Explain how VLAN can be implemented using VLAN aware switches. **(6+7=13)**

3. (a) Why do multimedia applications use UDP instead of TCP? **(7)**

   (b) Explain with a suitable scenario how 'Delayed Duplicate' problem occurs in an End to End system. How does TCP attempt to solve 'Delayed Duplicate' problem? **(8+6=14)**

   (c) Explain how the problem of sending small window update by receiver (known as the 'Silly Window Syndrome') may occur in TCP. What was Clark's solution to this problem? What is the function of 'Persistence Timer' in TCP? **(7+3+4=14)**

4. (a) Describe Jacobson algorithm for calculating timeout value of retransmission timer in TCP? What is the problem of updating RTT on retransmitted segments? What was Karn's solution to this problem? **(6+4+3=13)**

Contd P/2

CSE 451

Contd ... Q. No. 4

(b) Describe TCP congestion control algorithm with a suitable example scenario. Your description must include answers to the followings. (1

(i) Usage of the variables 'Congestion Window' and Threshold'. What are the initial values of these variables? How are subsequent values calculated?

(ii) How does the sender calculate the size of sending window?

(iii) When does congestion window grow exponentially and when does it grow linearly? What is the motivation behind such approach?

(iv) How is congestion window increased on each successful transmission during exponential increase (slow start) and during additive increase?

(v) What is the difference in response to the events: timeout and three duplicate ACK? What is the reason behind such difference?

(vi) An example showing graphical plot of congestion window against transmission number illustrating the algorithm.

(c) What is the disadvantage of sending small size segments? Describe Nagle's algorithm for limiting small size segments from sender. (3+4=

SECTION – B

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

5. (a) What do you mean by layers in Computer networks? (

(b) Show the relationship between a service and a protocol. (

(c) Describe different layers in TCP/IP protocol suite. (1

(d) Show protocol stack of a PC work station, router and network interface card with an example of a message being transferred between two PC workstation connected through a subnetwork of routers. (1

6. (a) What do you mean by Domain Name System? Show the hierarchy of domains with examples. (

(b) What is the meaning and necessity of time to live field in DNS record of DNS server? Show with example. (

(c) Describe base 64 encoding technique to transmit binary files through email. (1

(d) What do you mean by "IP tunneling"? Discuss the role of "IP tunneling" to establish a Virtual Private Network. (

CSE 451

7. (a) Describe the steps of building link state packets in link state routing. Describe how pruning is done in multicast routing if link state routing is used as basic routing protocol. **(15)**

   (b) Describe the phenomenon congestion in a network. What are the main factors of congestion in network? Write down the mechanism for congestion control using choke packets. **(12)**

   (c) How is flooding a mechanism of routing packets? Explain the advantages and disadvantages. **(8)**

8. (a) What is the advantage of feeding a leaky bucket from the output of token bucket. Demonstrate with illustrate examples. **(10)**

   (b) Explain jitter as a QoS parameter. Show techniques to reduce jitter effect. **(8)**

   (c) Describe RARP with a practical example. **(7)**

   (d) Show that all the necessary fields of IPV4 can be properly supported by IPV6 fields. **(10)**

A. S. M. Sohidull Islam

L-4/T-2/EEE Date : 18/12/2012

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **CSE 453** (Computer Architecture)

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) How can you manually trap for unsigned overflow in MIPS? Write down the corresponding MIPS assembly code. **(10)**

   (b) Suppose you have a hardware-architecture for multiplication as shown in Figure 1(b). Show the step by step simulation of multiplication where multiplicand = 9 and Multiplier = 5. **(10)**

   (c) For the division hardware-architecture shown in Figure 1(c), write down the corresponding flowchart. Mention the initial steps clearly. **(15)**

2. (a) Draw the block diagram of an arithmetic unit dedicated to floating point addition. **(15)**

   (b) Suppose that you want to add the instruction lw_inc to the single cycle data-path shown in Fig. 2(b-i). Add any necessary data-paths, adders and control signals to the single-cycle data-path. Also modify the Table in Figure 2(b-ii) accordingly. Assume an ALU with ALU control defined by the Table in Figure 2(b-iii). The instruction lw_inc is a variant of the lw (load word) instruction, which increments the index register after loading word from memory. It corresponds to the following two instructions: **(15)**

   ```
   lw      $rs, offset($rt)
   addi    $rt,$rt, 1
   ```

   (c) "The clock cycle for a machine with a single clock for all instructions will be determined by the longest instruction" - Do you agree with this statement? Why? **(5)**

3. (a) Consider the multi-cycle data-path of Figure 3(a). If the register file is altered so that it has only one read port, then describe any additional changes that you will need to make to the data-path in order to support this modification. Also draw the complete finite state machine control for this modified data-path. **(20)**

   (b) Write down the table containing the microinstructions for the modified data-path described in Question 3(a). **(15)**

4. (a) For the following set of sequential instructions running in a pipelined architecture, determine the potential hazards and graphically show how to solve them. **(15)**

Contd P/2

CSE 453

Contd ... Q. No. 4(a)

```
lw    $2, 20($1)
and   $4, $2, $5
or    $8, $2, $4
add   $9, $4, $2
slt   $1, $6, $7
```

(b) Write down the logic of forwarding unit to handle Execution Hazard and Memory Hazard for the pipelined architecture shown in Figure 4(b). **(10)**

(c) Draw the states of a 2-bit prediction scheme in dynamic branch prediction. **(10)**

SECTION – B

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

5. (a) Write the five basic steps of the overall operation of a computer. **(5)**

(b) Draw the diagram of the organization of a computer consisting of PC, ALU, register bank and two types of memory. Give proper connections among them so that the connections justify the overall operation of a computer. **(8)**

(c) There should be two loop connections in your diagram of Q. No. 5(b): (register bank → ALU → register bank) and (register bank data → memory → register bank). How do these two loops contribute to the operation of the computer? - explain. **(5+5=10)**

(d) Write two objectives of a computer architect. Write two differences between instruction set architecture and machine architecture. **(2+4=6)**

(e) What are the two types of information handled by a computer? Write two properties of each type of information. **(2+4=6)**

6. (a) State the four principles of hardware design. **(4×2=8)**

(b) Define alignment restriction and spilling register. **(3+3=6)**

(c) Write the name and meaning of each field of a 32 bit R-type MIPS instructions. **(4+6=10)**

(d) Write the six steps that a program follows while executing a procedure. State the convention of allocating 32 bits registers for procedure calling by MIPS software. **(6+5=11)**

7. (a) "One way of interconnecting all functional unit of a computer is to use a single bus"- write three advantages and disadvantages of such organization. **(3+3=6)**

(b) What is the way of making the faster unit of a computer compatible with the slower units of it? **(3)**

(c) Consider a simple system built on an 8-bit microprocessor. The device provides 16-bit address-line (0000H - FFFFH); 32 kB of address space is allotted to RAM, 16 kB for ROM and the remainder to a variety of I/O devices. Establish the memory map of the system. **(8)**

Contd P/3

CSE 453

Contd ... Q. No. 7(c)

(d) Define: **(6×3=18)**

(i) Return address

(ii) Program counter

(iii) Caller

(iv) Callee

(v) Stack pointer

(vi) Address decoder

8. (a) Define general purpose register, memory access register and memory data register. **(6)**

(b) Describe the processing steps of the execution of a program. **(16)**

(c) Define: **(4×2=8)**

(i) Global pointer

(ii) Activation record

(iii) Frame pointer

(iv) Text segment

(d) Draw the figure of MIPS memory allocation for program and data. **(5)**

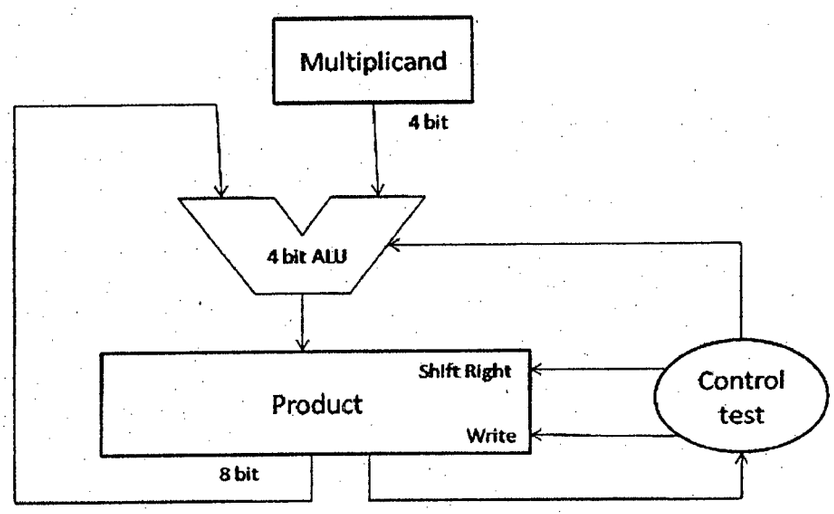

Figure 1(b)

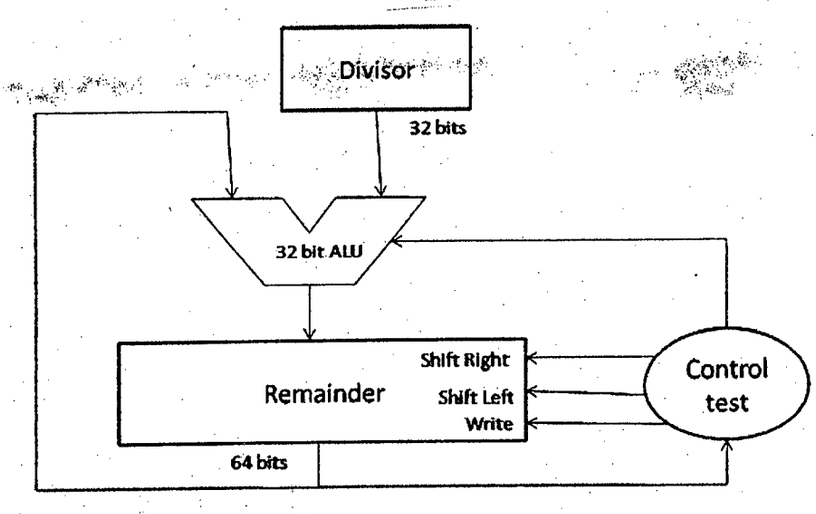

Figure 1(c)

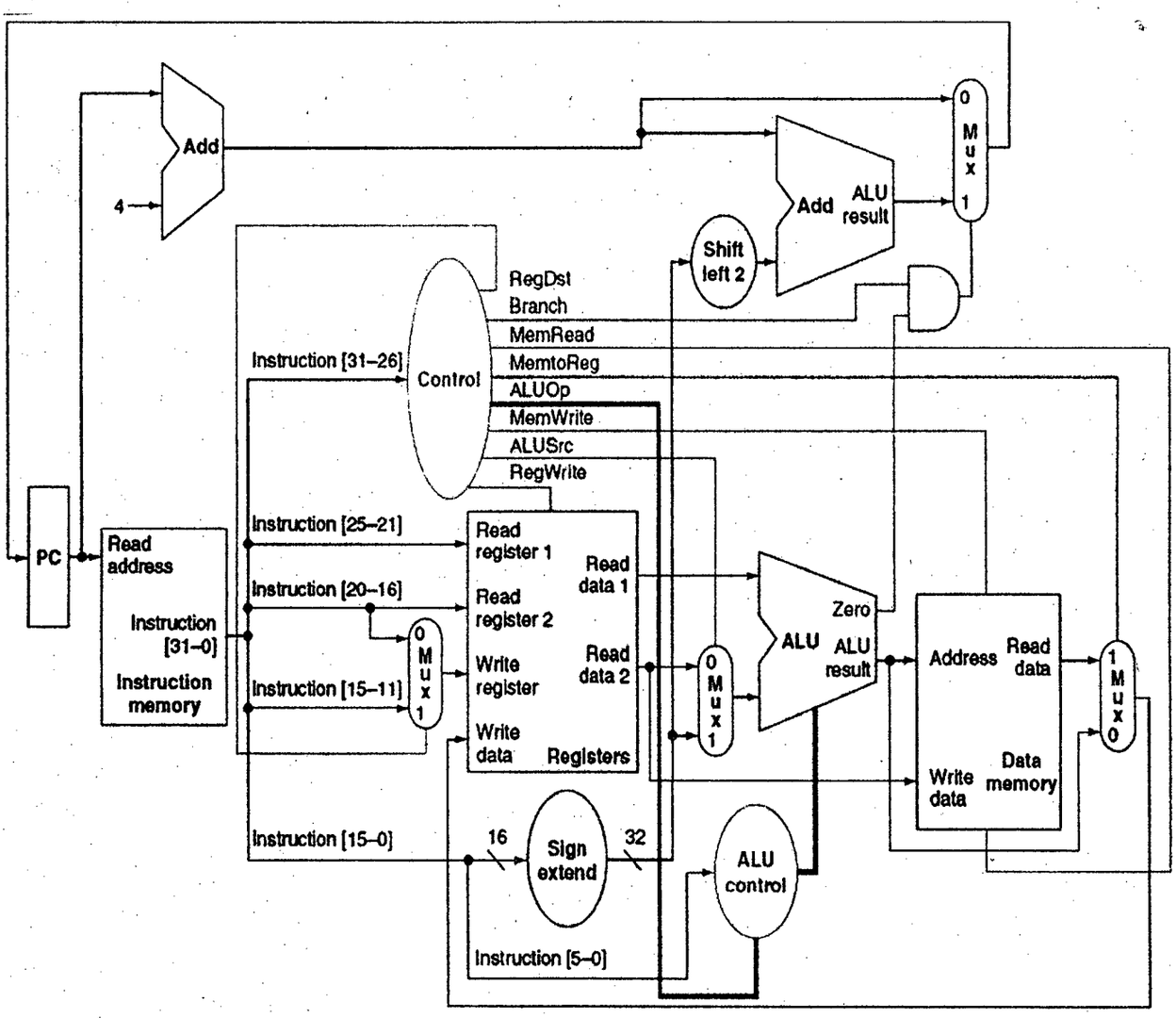

Figure 2(b-i)

Input or output	Signal name	R-format	lw	sw	beq
Inputs	Op5	0	1	1	0
	Op4	0	0	0	0
	Op3	0	0	1	0
	Op2	0	0	0	1
	Op1	0	1	1	0
	Op0	0	1	1	0
Outputs	RegDst	1	0	X	X
	ALUSrc	0	1	1	0
	MemtoReg	0	1	X	X
	RegWrite	1	1	0	0
	MemRead	0	1	0	0
	MemWrite	0	0	1	0
	Branch	0	0	0	1
	ALUOp1	1	0	0	0
	ALUOp0	0	0	0	1

Figure 2(b-ii)

Instruction opcode	ALUOp	Instruction operation	Funct field	Desired ALU action	ALU control input
LW	00	load word	XXXXXX	add	0010
SW	00	store word	XXXXXX	add	0010
Branch equal	01	branch equal	XXXXXX	subtract	0110
R-type	10	add	100000	add	0010
R-type	10	subtract	100010	subtract	0110
R-type	10	AND	100100	and	0000
R-type	10	OR	100101	or	0001
R-type	10	set on less than	101010	set on less than	0111

Figure 2(b-iii)

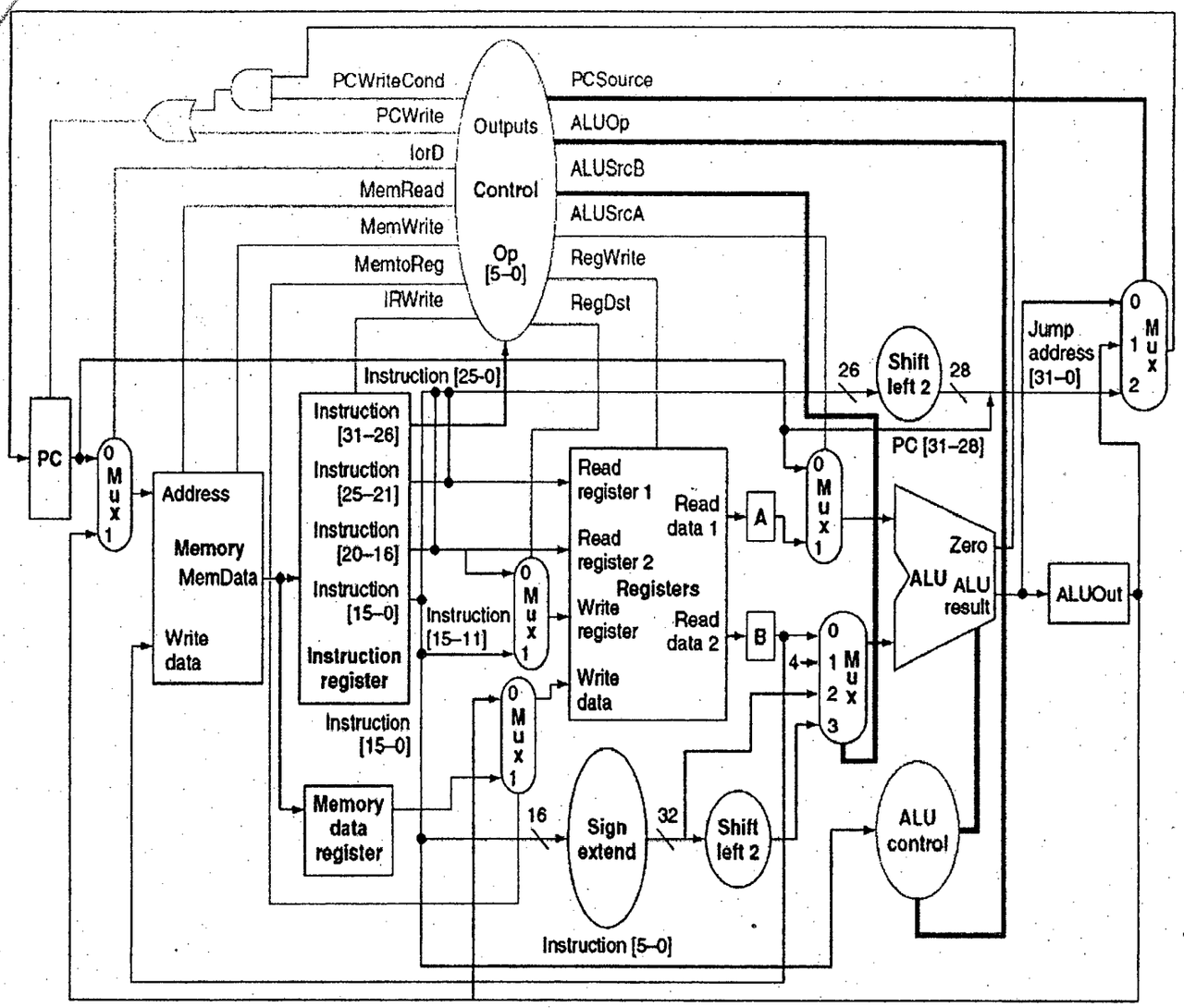

Figure 3(a)

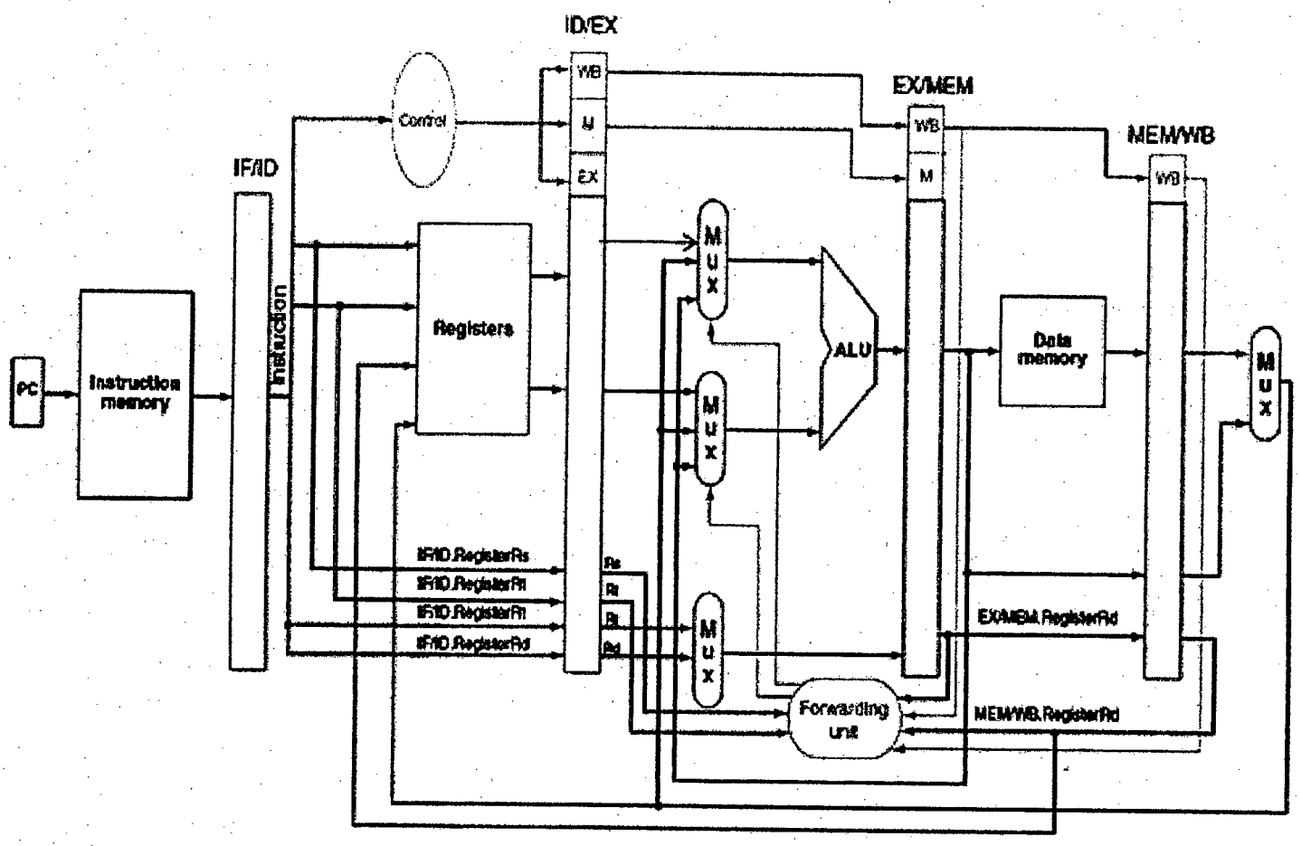

Figure 4(b)

L-4/T-2/EEE

Date : 01/01/2013

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 425** (Biomedical Instrumentation)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The questions are of equal value.

Symbols have their usual meanings.

1. (a) Sketch a typical ECG waveform and explain its different components.
   (b) Briefly explain the two phases of a cardiac cycle.

2. (a) Briefly describe the different types of atrio-ventricular blocks with necessary diagrams.
   (b) Explain the following terms: (i) heart murmur, (ii) normal heart sound and (iii) pitch of heart sound.

3. (a) Discuss the following:
   (i) resting heart rate, (ii) recovery heart rate and (iii) instantaneous heart rate.
   (b) Explain the geometric method for the analysis of heart rate variability.

4. (a) What is an EEG signal? Justify why an EEG signal may be used to identify different types of sleep disorders.
   (b) Write short notes on any three of the following:
   (i) Mean arterial pressure
   (ii) Korotkoff sound
   (iii) Sphygmomanometer
   (iv) Direct Measurement of BP.

SECTION – B

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

The figures in the margin indicate full marks.

5. (a) Describe the following terms: **(18)**
   (i) Index of refraction
   (ii) B-scan mode of ultrasonography
   (iii) ESPA Transducer

Contd P/2

EEE 425

Contd. Q. No. 5

(b) Answer the following questions:

(i) Why are Hydrogen nuclei most suitable for MRI? Why is Larmor frequency crucial to MRI? What happens when the RF ~~pulse~~ at the Larmor frequency applied? **(05)**

(ii) Describe the key points of MRI instrumentation. **(12)**

6. (a) Briefly describe Aperture impedance blood cell counter. **(17)**

(b) Give an overview of different types of clinical instrumentation. **(10)**

(c) Draw and explain the simplified schematic of a spectrophotometer. **(08)**

7. (a) Compare power line noise, electrode contact noise and electrosurgical noise based on their typical parameters and characteristics. **(15)**

(b) Write down the basics of Impedance Cardiography. **(20)**

8. (a) Write down the equation that Cole-Cole plot obeys. Derive the Cole-Cole system for practical measurements. **(10)**

(b) Describe major usage of X-Ray. Explain absorption and scattering of X-rays. **(17)**

(c) Describe: **(08)**

(i) Lead Collimating Plates

(ii) Scatter Radiation Grid
