L-4/T-2/EEE Date : 30/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

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) If a signal has a frequency 2% greater than the cut-off frequency of the crystal, determine the length at which the signal decays to $1/e$ of its value during incidence. **(10)**

   (b) Why optical branch of crystal vibration cannot be excited in a monatomic crystal? **(10)**

   (c) Plot the shapes of the optical and acoustic branches in the dispersion relation for four different ratios of masses: $M_1/M_2 = 10, 5, 2$, and 1. Show that in the case of two identical atoms, there is actually only one acoustic branch and no optical branch for the dispersion relation. **(15)**

2. (a) In a 1D diatomic lattice, find the relationship between the amplitude of vibrations of the two atoms in the acoustic and optical branches. **(12)**

   (b) Apply Schrödinger's equation to the case of a particle in a box and show that the energies of the particle are quantized. **(10)**

   (c) Discuss the nearly free electron approximation for a 1D lattice and find E versus k relations. Explain the discontinuity in the E-k curve at zone boundaries. **(13)**

3. (a) What is Bloch wave? **(8)**

   (b) Discuss the formation of allowed and forbidden energy bands on the basis of the Kronig-Penny model. **(12)**

   (c) Find expressions for the Einstein specific heat in the limit of (a) very low temperatures, (b) very high temperatures. **(15)**

4. (a) How can ionicity of a crystal be measured using the Reststrahlen effect? **(10)**

   (b) The velocity of sound in a solid is equal to 3.5×10^5 cm/s and the inter-atomic distance is 5 Å. Find the cut-off frequency, assuming that the lattice is linear monatomic. **(12)**

   (c) Consider a well 5 nm wide and 0.3 eV deep in GaAs. The lowest state in this well has a binding energy of 0.21 eV so $\kappa = 0.61$ nm^{-1} outside the well. Estimate the splitting when two such wells are separated by a 5 nm barrier. Assume the effective mass is 0.067 times the electron mass. Make assumptions if necessary. **(13)**

Contd P/2

EEE 461

SECTION – B

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

5. (a) Compare Si and GaAs in applications to photonic devices such as in lasers and detectors. **(10)**

   (b) Write a short note on ballistic transport. Explain with a specific example how ballistic transport can be allowed in devices. **(12)**

   (c) How will the drift velocity change with applied electric field due to (a) intra-valley scattering and (b) inter-valley scattering in GaAs material? **(13)**

6. (a) What happens to the energy of the electron when the electron is scattered by an impurity? Explain both transient and steady-state dynamics. **(10)**

   (b) Derive scattering rate from an initial state i to a final state f using Fermi's Golden rule due to a time-independent perturbation. **(12)**

   (c) Calculate the oscillator strength for the transition from the ground state (n = 1) to the first (n = 2) and second (n = 3) excited states in an infinitely deep well that has a length of 10 nm. How would you select the levels to make this quantum well work as a laser or detector? **(13)**

7. (a) How can you change the "selection rule" of scattering in a single quantum well? Explain. **(10)**

   (b) Explain how the electron-photon interaction in a quantum well is different from the electron-photon interaction in a bulk material. **(12)**

   (c) Derive an expression for the reflection parameter r of a double-barrier structure using partial waves. **(13)**

8. (a) Write the expressions for absorption and emission scattering rates when an electron is interacted by a time harmonic perturbation. Discuss different terms in the expressions. **(10)**

   (b) Draw the transmission coefficient of current density through a square potential barrier of length d when the energy of the electron varies. Also draw the transmission coefficient when the barrier length is changed to 0.5d and 1.5d. Comment on the change of transmission coefficient curve with the change of the barrier length. **(12)**

   (c) The current through a one-dimensional resonant-tunneling diode should be constant while the resonance is within the range of incoming energies, and zero otherwise. What sets the width of the transitions? What is the effect of temperature on the width of the transition? **(13)**

L-4/T-2/EEE **Date : 16/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

Sub : **EEE 437** (Digital 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**.

The symbols have their usual meanings, unless stated otherwise.

1. (a) Draw the block diagram of a typical digital communication system. Also show the components of each block. **(10)**

   (b) Explain the term 'Prefix code'. State Kraft's inequality for prefix codes. Prove that, it is possible to construct a prefix code that satisfies the relation $H(X) \le \bar{l} \le H(X) + 1$. **(15)**

   (c) A message containing alphabets a, b, c is coded using Lempel Ziv algorithm. A '3 bit' encoding is used for the indices. At the receiver side, the following bit stream is received– 000 001 100 010 **(10)**

   What was the transmitted message?

   The initial entries of the dictionary are given below

Index	Content
0	a
1	b
2	c

2. (a) Define 'mutual information'. Prove that $H(A:B) = H(B) - H(B \mid A)$. **(10)**

   (b) State Shannon-Hartley theorem. "Even with arbitrarily large bandwidth, arbitrarily fast error free communication is not possible" – mathematically prove this statement. Give physical explanation of this phenomenon. **(10)**

   (c) State and explain 'noisy channel coding theorem'. Suppose an engineer proposes a linear (n, k) block code with minimum distance d_{min} that satisfy the limit posed by 'noisy-channel coding theorem'. Prove that, **(15)**

$$d_{min} \ge \frac{2kq}{1 - H(q)} + 1$$

   where q is the cross-over probability of the channel.

3. (a) What are the desired properties of a line code? Compare Unipolar NRZ, Polar RZ, AMI and Manchester Codes in terms of these properties. **(12)**

   (b) Derive the expression of PSD (Power spectral density) of AMI code. **(10)**

   (c) What is 'Spread Spectrum'? How is a signal spread in the frequency domain? Draw the block diagram of the receiver in a DSSS system. Mathematically analyze how the signal is demodulated at the receiver side. What is processing gain? **(13)**

4. (a) Define ISI-free signal. Derive the odd symmetry condition for the magnitude spectrum of an ISI free signal. **(12)**

   (b) Specify the magnitude response of a baseband raised cosine channel which has an absolute bandwidth of 10 KHz, and which is appropriate for a baud rate of 16 kbaud. What is the filter's roll-off factor? **(10)**

Contd P/2

EEE 437

Contd ... Q. No 4

(c) In a line coding scheme, bit '0' is mapped to voltage level V_0 and bit '1' is mapped to voltage level V_1, where $V_1 > V_0$. The signal is passed through an AWGN channel with RMS noise value σ. At the receiving end, N samples are taken at each bit interval and their average is compared with the threshold $\frac{V_0 + V_1}{2}$ to take the decision accordingly. Show that, the bit error probability is given by, **(13)**

$$P_e = Q\left(\frac{\sqrt{N}\,\Delta V}{2\sigma}\right), \text{ where } \Delta V = V_1 - V_0$$

SECTION – B

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

5. Consider the signal space diagram shown in Fig. for Q. No. 5. **(5+10+10+10)**

(i) Determine and sketch the two signals $s_1(t)$ and $s_2(t)$.

(ii) The two signals $s_1(t)$ and $s_2(t)$ are used for the transmission of equally likely bits 0 and 1, respectively, over an AWGN channel. Clearly draw the decision boundary and the decision regions of the optimum receiver. Write the expression for the optimum decision rule.

(iii) Find and sketch the two orthonormal basis functions $\hat{\phi}_1(t)$ and $\hat{\phi}_2(t)$ such that the optimum receiver can be implemented using only the projection r_2 of the received signal r(t) onto the basis function $\hat{\phi}_2(t)$. Draw the block diagram of such a receiver that uses a matched filter.

(iv) Consider now the following arguments put forth by an engineer. He reasons that since the component of the signals along $\hat{\phi}_1(t)$ is not useful at the receiver in determining which bit was transmitted, one should not even transmit this component of the signal. Thus he modifies the transmitted signal as follows:

$S_1^{(M)}(t) = S_1(t) - (\text{component of } S_1(t) \text{ along } \hat{\phi}_1(t))$

$S_2^{(M)}(t) = S_2(t) - (\text{components of } S_2(t) \text{ along } \hat{\phi}_1(t))$

Clearly identify the locations of $S_1^{(M)}(t)$ and $S_2^{(M)}(t)$ in the signal space diagram. What is the average energy of this signal set? Compare it to the average energy of the original set.

6. (a) Compare BASK, BPSK and BFSK in terms of error performance and bandwidth requirement. **(10)**

(b) Describe QPSK modulation. Draw the signal space plot and draw the block diagram of a minimum error probability receiver for this scheme. Also show that the bit error probability for QPSK is equal to $Q\left(\sqrt{\frac{Es}{No}}\right)$, where the symbols have their usual meanings. **(5+5+10)**

(c) What is the fundamental difference between MSK and GMSK? **(5)**

Contd P/3

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7. (a) Starting from the equation of M-PSK signal, derive the expression of the minimum Euclidean distance between two points of an M-PSK constellation. Using this expression, derive the appropriate upper and lower limits for bit error probability in M-PSK modulation scheme. **(8+12)**

(b) "An arbitrary low probability of error can be achieved in M-FSK, provided that SNR per bit is greater than 1.42 dB" – prove. **(15)**

8. (a) Prove that, for a (n, k) block code, the maximum number of correctable errors is given by $\left[\frac{d_{min} - 1}{2}\right]$. **(10)**

(b) Consider the generator matrix – **(5+15)**

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

For a (6, 3) linear block coder and the bit sequence 101100

(i) What is the output code sequence for the block coder?

(ii) How many bits remain as error after decoding if a decoder receives the code sequence as 100 100 100 100?

(c) Consider a convolutional coder with n = 2, k = 1, k = 3. The generator vectors are given as $g_1 = [1\ 0\ 1]$, $g_2 = [1\ 1\ 0]$. Draw state diagram for the encoder. **(5)**

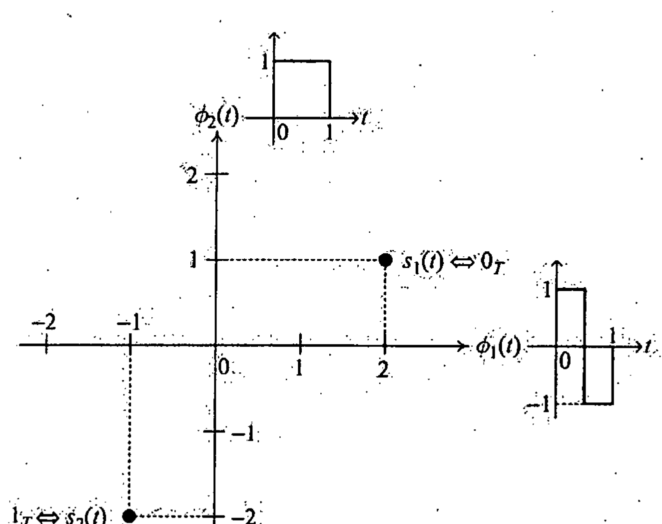


Fig. for Q. No. 5

L-4/T-2/EEE **Date : 16/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

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) Distinguish between active and passive faults with examples. **(5)**

   (b) Distinguish between fuse, MCB, MCCB, isolator, contactor, load break switch and circuit breaker. **(10)**

   (c) Describe using appropriate diagram the working principle of a single pressure puffer type SF_6 circuit breaker. **(12)**

   (d) In a short circuit test on a three-phase circuit breaker the peak restriking voltage and the natural frequency of oscillation obtained were respectively 100 kV and 7.143 kHz. Determine the average rate of rise of transient recovery voltage. **(8)**

2. (a) (i) For the following system determine the appropriate CT ratios needed in the differential protection of the generator against interval faults at a allocation F. **(5)**

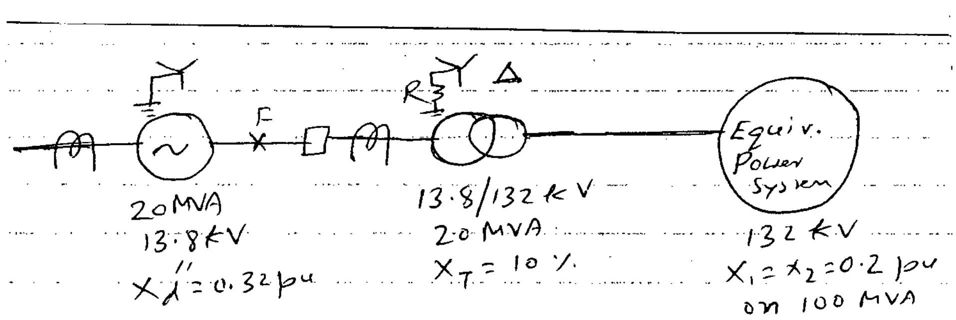


Fig. for Q. 2(a)

   The value of resistance R in the neutral to ground path of the transformer's Y side is 19 ohms so that for a L-G fault at the point F the fault current does not exceed 400 Amps.

   (ii) Determine the fault currents for a three-phase fault at F before and after the generator is synchronized with the power system. **(10)**

   (iii) If the relay in the spill path of the differential relay is set to pick up at 0.4 Amp prove that it is able to trip the circuit breaker for the fault currents in (i) and (ii). **(8)**

   (b) Explain with necessary diagrams how a combination of a thermal overload relay and an over current relay can provide complete thermal protection of an induction motor. **(12)**

3. (a) Using an example show that the ratio of CTs used in the differential protection of a bus bar should be based on the feeder current that is maximum among all the incoming and outgoing feeders. **(13)**

Contd P/2

EEE 477

Contd ...Q. No. 3

(b) A 132 kV bus bar has 2 incoming and 4 outgoing lines with 500 Amps maximum in a line. Each CT's secondary resistance is 0.7 ohms, cable resistance is 2.0 ohms and rated secondary current is 1 Amp. The analog over current relay used in the differential protection has a resistance of 1.0 ohm. The magnetization current in each CT is 0.28 mA/volt up to 120 volts in the CT secondary circuit. The relay is set to pick up at 1.0 Amp.

(i) What should be the stabilizing resistance in series with the over current relay so that a maximum of 15000 Amps external fault current will not cause bus bar circuit breaker trip? **(8)**

(ii) What should be the voltage setting of the supervisory relay so that it can detect a break in the cable of a CT that was carrying 25 Amps or more? **(8)**

(iii) Draw a diagram showing the connections of bus bar, 6 lines, 6 CTs, the stabilizing resistance, the over current relay and the supervisory relay. **(6)**

4. (a) What is the main function of a pilot relay? Explain, with necessary diagrams, how does a pilot relay perform this function through direction comparison? **(5+10)**

(b) For a 11 kV 50 Hz radial feeder as shown in the Fig. (i) determine the tap (plug) setting and time dial setting (TDS) for each relay so that a time coordination is achieved among the over current relays starting from the tail end of the feeder. Suppose the relays are analog type having moderately inverse operating characteristics shown in the Fig. (ii). The available tap (plug) settings for each relay are 4, 5, 6, 7, 8, 10 and 12. Use the most appropriate one. Each circuit breaker operates in 5 cycles. Assume an error margin (overshoot) of 0.3 sec where needed. The three phase fault current at buses 1, 2, 3 are respectively 2.4, 2.7 and 3 kA. **(20)**

SECTION – B

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

5. (a) What are the drawbacks of the simple differential relay? **(5)**

(b) Explain how the percentage differential relay overcomes the drawbacks of the simple differential relay. How do you adjust the slope of the operating characteristics of an analog percentage differential relay? **(13+5)**

(c) Explain the principle of percentage differential relay with harmonic restraint. **(12)**

6. (a) Draw the layouts of single, ring and duplicate bus bar systems. Also, briefly discuss their advantages and disadvantages. **(5+5+5)**

(b) Discuss how the trapped gases in the conservator can give clue to the type of damage that takes place inside the transformer. **(10)**

(c) What is over-fluxing in the transformer? Why the transformer should be tripped if there is a prolonged over-excitation? **(3+7)**

Contd P/3

EEE 477

7. (a) What are the factors that influence the choice of plug setting of a relays? **(5)**

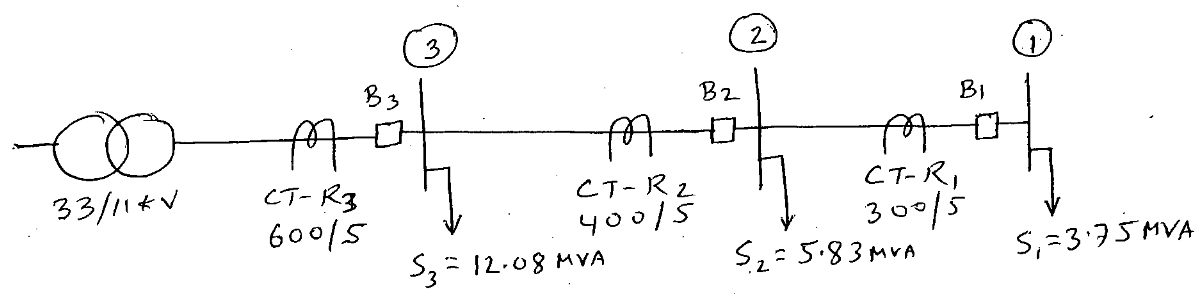
(b) Write the formula used to derive different (normal, very, extremely, long-time) degrees of inverse time characteristics in a microprocessor overcurrent relay that comply with BS142. **(5)**

(c) How the acquired current or voltage signal is handled in a typical microprocessor relay. **(15)**

(d) Draw the flowchart for a typical numerical overcurrent relay algorithm. **(10)**

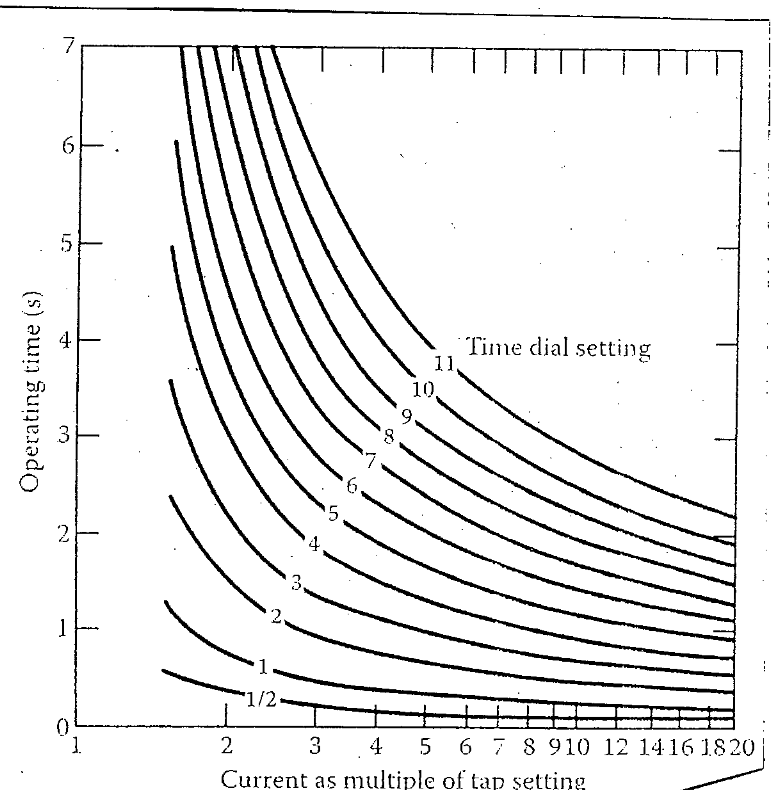
8. (a) Describe Mann and Morrison method for numerical distance protection of transmission line. **(15)**

(b) Explain trip law for simple impedance relay and mho relay using universal torque equation. **(10+10)**



(i)

(ii)



Figs. for Q. 4 (b)

L-4/T-2/EEE **Date : 16/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

Full Marks: 280 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) A chip designed in 180 nm process has chip size of 4 mm × 4 mm, run at a clock frequency of 1 GHz and consumes 40 mW dynamic power. The process is scaled to 90 nm using ideal field scaling. Calculate the area, clock frequency and dynamic power dissipation of the chip in the 90 nm process. Assume that transistor speed sets clock rate. **(15)**

(b) Consider a 5 mm long 0.32 μm wide metal1 wire in a 90 nm process. The sheet resistance is 0.05 Ω/ and capacitance is 0.2 fF/μm. A 10× unit size inverter connected at one end of the wire drive a 2× inverters at the other 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 size inverter NMOS width is 4λ and PMOS width is 8λ. Assume $\mu_n = 2\ \mu_p$. **(20)**

   (i) Construct a π2 model of the wire and estimate the 50% propagation delay using Elmore delay model.

   (ii) What would be the 50% propagation delay if distributed resistance and capacitance would be assumed for the metal wire.

   (iii) If the designer wishes to use repeater to minimize RC delay, calculate the optimum number and size of the repeater. Also calculate the delay after using the repeater.

2. (a) A 3-input NAND gate is designed for worst case equal rise and fall resistance. Consider the falling output transition occurring with two input held at '1' and the other input rising from '0' to '1'. Using Elmore delay model find the corresponding delay when the falling signal is connected (i) closest to the output, (ii) most far from the output. Assume $\mu_n = 3\mu_p$. **(15)**

(b) A ring oscillator is constructed from N-stage inverter with propagation delay τ. Derive an expression of oscillation frequency of the ring oscillator in terms of N and τ. What will be the frequency for 35-stage ring oscillator fabricated in a 90 nm process with τ = 10 ps. **(10)**

(c) In a carry look ahead adder the carry out of each bit of a 4-bit adder must be computed. Show the multiple output domino logic implementation of the carry out signals. **(10)**

3. (a) For each of the following sequencing styles, determine the maximum logic propagation delay available within a 500 ps clock cycle. Assume there is zero clock skew and no time borrowing takes place. **(9)**

   (i) Flip-Flops

   (ii) Two-phase transparent latches

   (iii) Pulsed latches with 80 ps pulse width.

Contd P/2

EEE 457

Contd ... Q. No. 3

Use the following timing parameters.

	Setup time	Clk-to-Q delay	D-to-Q delay	Contamination delay	Hold Time
Flip-flop	65 ps	50 ps	n/a	35 ps	30 ps
Latches	25 ps	50 ps	40 ps	35 ps	30 ps

(b) Show the design flow of standard cell placement and routing. Write the meaning of the following file format and explain where in the design flow the files are used: LEF, DEF, ESPF and SDF. **(10)**

(c) Explain how the following problems have been overcome in modern nanometer CMOS process: **(16)**

- (i) Scaling of MOS gate dielectric
- (ii) Shallow junction resistance (parasitic source/drain resistance)
- (iii) Scaling of device isolation
- (iv) Hot electron degradation.

4. (a) What are the origins of clock skew in an IC. Discuss two methods of clock distribution network which can reduce/eliminate clock skew. **(8)**

(b) A 1.2 V chip switches from an idle mode consuming 5 W to a full-power mode consuming 53 W. The transition takes 10 clock cycles at 1 GHz. The supply inductance is 0.1 nH. What is the supply voltage droop? **(6)**

How much bypass capacitance is needed to ensure no more than 100 mV supply droop?

(c) Draw the circuit diagram of a bi-directional I/O pad which has proper ESD protection and an enable signal which control the input or output mode of the pad. Explain the operation of the circuit. **(12)**

(d) With the aid of schematic diagram describe the working principle of Wallace tree multiplier and explain how it reduce multiplication time. **(9)**

SECTION – B

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

If any question has missing data, make a reasonable assumption and state it in your solution.

5. (a) Draw the transistor level circuit diagram of a 4 × 4 bit NOR ROM which stores the following data: **(10)**

First Row	0	1	1	1
	1	0	0	1
	0	1	0	0
	0	1	1	1
	First Column			

(b) Consider 512 × 512 array of a Paseudo NMOS NOR ROM in a 1.2 μm process. The composite layout is shown in Fig. 5(b) where the basic cell is also identified. The word line is implemented in polysilicon (poly) and the bit line is implemented in aluminum (metal). Calculate the word line delay and the bit line dealy. Make reasonable assumptions. The following data are given: **(25)**

Contd P/3

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Contd ... Q. No. 5(b)

Poly sheet resistance = 10 ohm/sq, Poly width = 2 λ, Metal sheet Resistance = 0.07 ohm/sq, Metal width = 4 λ, Diffusion width = 4 λ, Gate oxide capacitance = 1.76 fF/μm^2, Poly-substrate capacitance = 0.058 fF/μm^2, Poly-Substrate fringing capacitance = 0.043 fF/μm, Metal-substrate capacitance = 0.031 fF/μm^2, Metal fringing capacitance = 0.044 fF/μm, N+diff-Substrate capacitance at 0V = 0.3 fF/μm^2, N+-diff side wall capacitance = 0.8 fF/μm, gate overlap capacitance = 0.43 fF/μm, Keq = 0.375 for Votlage effect 2.5/5 V, $\mu_n C_{ox}$ = 20 μA/V^2, $\mu_p C_{ox}$ = 5 μA/V^2, Aspect ratio of pull up and pull down transistors are 6 μm/1.2 μm and 2.4 μm/1.2 μm respectively, V_{m}= $|V_{tp}|$ = 0.75 and bit line switches between 5 V and 2.5 V.

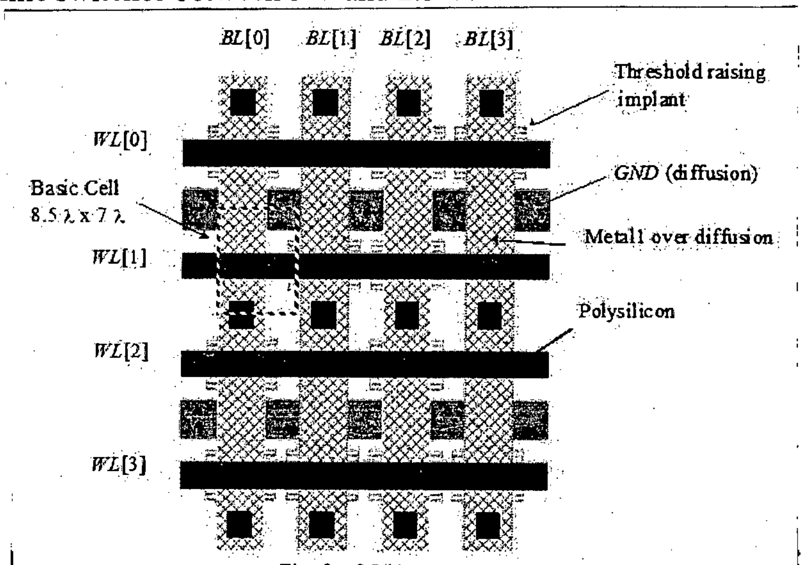

Fig. for Q5(b)

6. (a) A 1-Transistor DRAM cell has a cell memory capacitance of 5 fF. There are 400 DRAM cell in each column and the drain capacitance of each transistor is 0.5 fF. The columns are pre-charged to 2.5 volts before read operation. If a '1' is stored in the memory cell capacitance by charging it to 5 V, determine the final voltage after the read operation if no sense amplifier is used. **(10)**

(b) Calculate the minimum computation time required by a 64-bit adder in (i) Ripple carry (ii) Carry select and (iii) carry skip configuration. The propagation delay of the carry signal through the 1-bit adder cell is 1.0 ns and the time needed by the multiplexer to select the actual output is also 1.0 ns. Assume an appropriate model for the worst case carry propagation of the carry skip adder. **(10)**

Show schematic diagram of the first two blocks of carry select and carry skip adder.

(c) A digital system in a 1.2 V 100 nm process has 200 million transistors, of which 20 millions are in logic gates and the reminder in memory arrays. The average logic transistor width is 12 λ and the average memory transistor width is 4 λ. The process has two threshold voltage and two oxide thicknesses. Subthreshold leakage for OFF device is 20 nA/μm for low threshold devices and 0.02 nA/μm for high threshold devices. Gate leakage is 3 nA/μm for thin oxide and 0.002 nA/μm for thick oxides. Memory uses low leakage devices everywhere. Logic uses low-leakage devices in all but 20% of the path that are most critical for performance. Diode leakage is negligible. Estimate the static power consumption. **(15)**

How would the power consumption change if the low leakage devices were not available?

Contd P/4

EEE 457

7. (a) What are the different fault models used in analyzing faults in VLSI circuits? A stuck open fault occurs at point O_1 in a three input NAND gate shown below. Find the test vectors that will be able to identify the fault. **(10)**

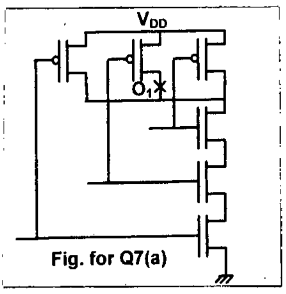

Fig. for Q7(a)

(b) Explain how serial-scan testing is implemented by modifying the conventional register. Show the circuit diagram of a scannable D-Flip-flop and explain its operation. **(10)**

(c) Explain how a Pseudo-Random Sequence Generator (PRSG) can be used to test a 3-bit datapath. How would the outputs be collected and checked? Show the schematic diagram of the PRSG you will use in your circuit and write down the sequences it will generate. **(15)**

8. (a) Write the expression for total power dissipation of an integrating circuit including dynamic, short-circuit and leakage power dissipation. **(6)**

(b) Show the circuit diagram of a 3-input NOR gate with sleepy keeper configuration and explain how sleepy keeper can reduce power consumption and at the same time avoid memory loss during sleep mode. **(12)**

(c) Design a finite state machine (FSM) to implement a synchronous level-to-pulse converter which produces a single cycle pulse each time its input goes high. The system will be used as a push button for a pedestrian crossing and the functionality is graphically shown below. **(17)**

Write the state diagram, state table, state assigned table and derive the logic expression, and show the implementation of the sequential circuit.

Write system verilog code for the FSM and also write a test bench in system verilog to test the FSM.

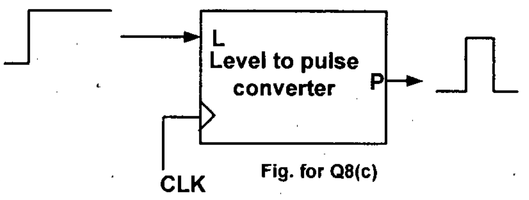

Fig. for Q8(c)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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 "Dettatron" circuit for generation of HVDC.

   (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) percentage ripple, (ii) the regulation, and (iii) the optimum number of stages for minimum regulation or voltage drop.

2. (a) Explain the negative corona discharge phenomena. What are the industrial application of corona?

   (b) What is corona onset level? Find the value of ac critical onset voltage, E_0, when air pressure is 100 kPa and the air temperature is 20°C.

3. (a) Define insulation coordination. Describe statistical method of insulation coordination.

   (b) Describe the statistical safety factor and its relation to the risk of failure (R) with appropriate diagrams.

4. (a) What are the different principles of breakdown in insulating liquids? Explain suspended particle theory.

   (b) Explain the mechanism of lightning strokes, with neat diagram, showing charge distribution and corresponding current surge at various stages of lightning discharges.

SECTION – B

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

5. (a) What are the different methods used for high voltage measurements? Explain with a neat diagram the operation of electrostatic voltmeter used for measurement of DC and AC voltages.

   (b) What are the quantities that can be measured by "Peak-Voltmeter"? Explain its operation.

Contd P/2

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6. (a) What are the different mechanism of breakdown is solid dielectrics? Describe erosion breakdown showing the voltage and current waveshapes of partial discharge in voids in solid dielectrics.

   (b) A solid dielectric specimen of dielectric constant of 4.0 shown in the Figure below has an internal void of thickness 1 mm. The specimen is 10 mm thick and is subjected to a voltage of 80 kV (rms). 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.

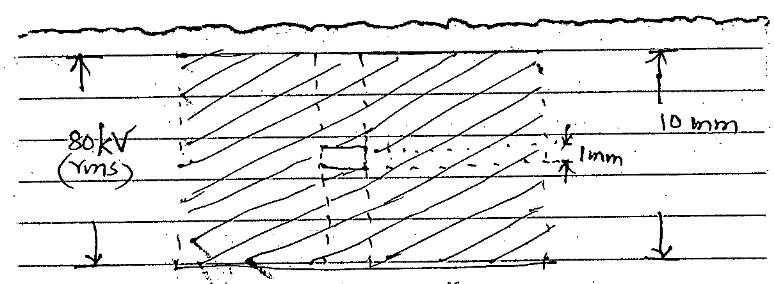

Figure for Q. No. 6(b)

7. (a) What is streamer mechanism of breakdown of gases? Discuss the mechanism proposed by Raether.

   (b) Explain the correlation between insulation and protection levels.

8. (a) Define "Impulse Voltage". Draw and explain lighting and switching impulses.

   (b) A circuit diagram for the single-stage impulse generator is shown below. Starting from first principle derive the expression for output voltage, the time for voltage rise to peak value and the voltage efficiency of the generation. The symbols have their usual meanings.

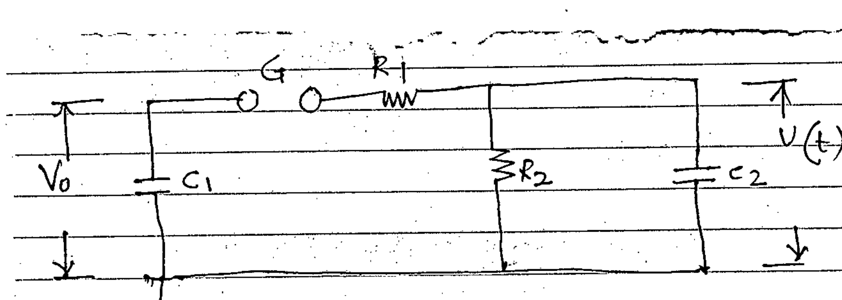

Figure for Q. No. 8(b)

L-4/T-2/EEE **Date : 21/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

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**.

Symbols have their usual meanings.

1. (a) Define the linear time variant impulse response of a wireless channel and find its expression for a multipath propagation environment. **(10)**

   (b) Express the following transfer functions of a wireless channel and show their inter-relationships. **(15)**

   (i) $H(t, f)$ (ii) $H(\gamma, \tau)$ (iii) $H(\gamma, f)$

   Explain their significances.

   (c) Define delay spread, Doppler Spread, coherence bandwidth and coherence time of a wireless channel. Explain channel behavior for the following cases: **(10)**

   (i) signal bandwidth higher than coherence bandwidth; (ii) symbol duration smaller than the coherence time.

2. (a) What is meant by co-channel interference (CCI) and how does it occur in a mobile cellular communication system? Derive an expression of carrier to CCI ratio (C/CCI) for a hexagonal cell structure. **(10)**

   (b) Show that for a hexagonal cell structure **(10)**

   $$D/R = \sqrt{3K}$$

   (c) A cellular communication system with hexagonal cell structure requires a minimum C/CCI of 23 dB at a location where path loss exponent $\gamma = 3.5$. The cell radius is 2.5 Km. Determine: **(15)**

   (i) Frequency reuse ratio;

   (ii) Frequency reuse factor;

   (iii) Cell coverage and coverage of a cluster.

3. (a) What are the purpose of multiple access techniques in a mobile cellular communication system? Explain the operational principles of the following techniques: **(10)**

   (i) FDMA-TDD, (ii) TDMA-FDD, (iii) TDMA-TDD, (iv) OFDMA-FDD

   (b) Define the spectral efficiency of a TDMA and FDMA mobile system. A mobile communication system is operating on FDMA-FDD with two-way system bandwidth of 50 MHz. The bandwidth of each channel is 200 KHz. Guard band at each end of the spectrum are 100 KHz. The frequency reuse factor is 9. Determine: **(15)**

Contd P/2

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

(i) total number of channels

(ii) spectral efficiency of the system if the cell radius is 2 Km and number of control channels is 24.

(c) What are the different types of fading that occurs in a mobile cellular environment? Explain their effects and mitigation techniques. **(10)**

4. (a) What is meant by spread-spectrum? Draw the block diagram of a direct sequence code division multiple access system and find the expression of signal to noise plus interference ratio at the receiver output. Draw the BER performance as a function of the number of users and explain. **(15)**

(b) What are the different types of user signature codes that are employed in a mobile cellular system? Give examples. **(10)**

(c) What are the benefits of multicarrier CDMA? With necessary block diagram, explain the principle of operation of an MC-CDMA system. **(10)**

SECTION – B

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

5. (a) Derive the expression of the probability density function (PDF) of signal to noise ratio (SNR) per bit under selection diversity of M independent Rayleigh fading channels. Also, derive the expressions of average SNR/bit and SNR gain. **(13+3+2=18)**

(b) Consider a maximal ratio combining diversity system with 2 independent Rayleigh fading channels and BPSK modulation. The overage SNR/bit of each channel of the 2 channels is 10 dB. Determine **(5+5+7=17)**

(i) the average SNR/bit of the system,

(ii) bit error rate if only one channel is used without any diversity, and

(iii) bit error rate with diversity.

6. (a) Briefly describe the functionalities of each component of the GSM reference architecture. **(18)**

(b) Briefly explain call origination and termination processes of a GSM system. **(17)**

7. (a) Describe the waveform encoding in IS-95 for Walsh Codes of length 64. **(10)**

(b) Briefly describe the forward traffic channel processing in IS-95 with rate set 2. What are the differences in forward traffic channel processing with rate set 1 and 2? **(10+3=13)**

(c) Briefly describe the reverse traffic channel processing for supplementary code channel in IS-95. What are the differences in a reverse traffic channel processing with fundamental code channel and supplementary code channel? **(9+3=12)**

8. (a) Why intersymbol interference (ISI) is lower in an OFDM system? Why is cyclic prefix added in OFDM? **(5+5=10)**

(b) Draw the block diagram of an OFDM system and briefly describe the functions of each component. **(18)**

(c) What are the main challenges in OFDM communications? **(7)**

L-4/T-2/EEE **Date : 21/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

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 figures in the margin indicate full marks.

1. (a) What does Poisson distribution represent? Derive the complete expression for Poisson distribution. **(16)**

(b) Establish the relationship of Poisson distribution with binomial distribution. **(10)**

(c) The probability of success in a single trial is 0.05. Calculate the probability that in 20 trials there will be exactly two successes using (a) the binomial distribution, and (b) the Poisson distribution. **(9)**

2. (a) Derive the expression for time-dependent probabilities of a single repairable component considering constant probability of failure or repair during any fixed interval of time. **(18)**

(b) The state space diagram and transition rates in f/hr of a continuous Markov process is shown in figure below. Calculate: **(17)**

(i) The limiting probabilities of each state.

(ii) The availability of the system.

(iii) The MITF, if state 1 is normally up state, state 2 is a standby state and state 3 is the failure state.

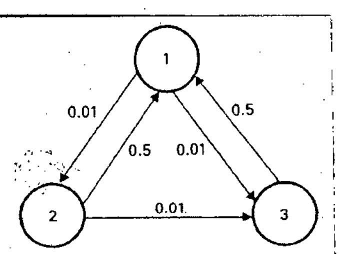

Figure for Q. no. 2(b)

3. (a) Introduce the concept of 'energy index of reliability'. What are its advantages over the 'loss of load expectation' index used for generating capacity reliability assessment? **(10)**

(b) Consider the load model shown in figure and the corresponding generation data in the table. **(25)**

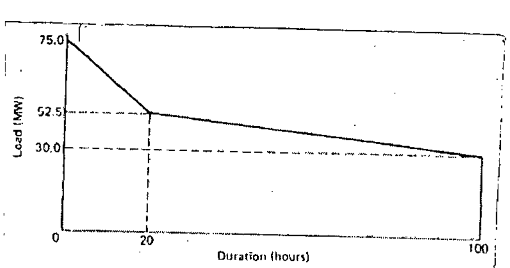

Figure for Q. no. 3(b)

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EEE 479

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

Table 3(b) Generation data

Unit no.	Capacity (MW)	Probability
1	0	0.05
	15	0.30
	25	0.65
2	0	0.03
	30	0.97
3	0	0.04
	20	0.96

Economic loading order is Units 1, 2 and 3. Calculate the expected energy not supplied (EENS) and the energy output of each generator.

4. (a) What are the problems of describing behavior of a generating system only by state probabilities? How does frequency and duration method of generating capacity reliability assessment overcome these? **(8)**

(b) The generating system data for a small power system is given in the table below: **(20)**

Table 4(b) Generating system data

Unit no.	Capacity (MW)	Failure rate (f/day)	Repair rate (r/day)
1	25	0.01	0.49
2	25	0.01	0.49
3	50	0.01	0.49

The system can reside in eight different states where all units are up or one or more units are down. The system is currently in a state where unit 1 is down and units 2 and 3 are up. The system can transit from this state to the following states:

(i) to a state where all units are up

(ii) to a state where units 1 and 2 are down, and unit 3 is up

(iii) to a state where units 1 and 3 are down, and unit 2 is up

Draw the complete state space diagram and find the generation model using frequency and duration method.

(c) Present the period load model used for risk assessment in frequency and duration method. **(7)**

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SECTION – B

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

5. (a) A power system planner proposes a plan consisting of two generating units of capacities 20 and 30 MW with FORs of 10% and 20%, respectively. The forecasted peak demand for the proposed power is 50 MW with an uncertainty of 40%. The forecasted peak is Gausian in nature with two more impulses at 40% off from the mean (50 MW). Evaluate LOLP for the proposed system.

   (b) Consider a power system with only one generating unit of 100 MW with a FOR of 10%. The system has a constant load of 60 MW. The management is planning to install another unit of 50 MW capacity with a FOR of 20%. What will be the load carrying capability of the new unit.

6. (a) What are the conditions that a probability distribution function should meet so that a Binomial expression is applicable for that distribution? Develop a general expression for the standard deviation of a Binomial distribution function.

   (b) The system shown in the figure is made up of ten components. Components 3, 4 and 5 are not identical and at least one component of this group must be available for system success. Componets 8, 9 and 10 are identical and for this particular group it is necessary that two out of three components function satisfactorily for system success. Write an expression for the system reliability in terms of given R values.

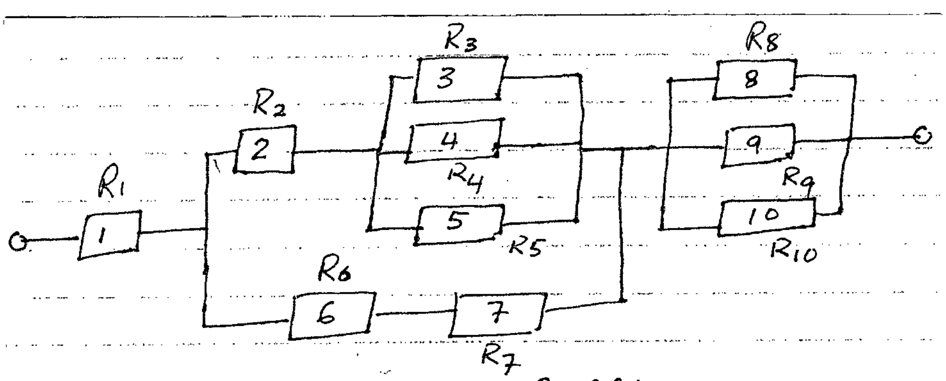

Figure for Q. 6(b)

7. (a) For a n component system, write the expression for 'Reliability' and 'Unreliability' if the components are in parallel. Draw the reliability characteristics (Reliability vs. number of components) for series and also for parallel system.

   (b) A system consists of four components in parallel having reliability of 0.99, 0.95, 0.98 and 0.97. What are the reliability and unreliability of the system?

8. Why does LOLP decrease with the interconnection between two utilities? Two utilities, X and Y, are interconnected through a tie line of capacity 3 MW. Calculate $LOLP_X$ and $LOLP_Y$, $LOLP_{X/Y}$ and $LOLP_{Y/X}$ using recursive approach. The generation and load data of two utilities are given in Table-1.

   Table 1 : Generation and Load data of two utilities.

	Utility X		Utility Y	
	Capacity (MW)	FOR	Capacity (MW)	FOR
Generation	5	.2	10	.2
	10	.1	2	.1
Peak Load (MW)	10.0		5.0	

L-4/T-2/EEE **Date : 21/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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**.

The symbols have their usual meanings. Make necessary assumptions.

1. (a) Why direct bandgap materials are suitable for optoelectronic device applications? Show schematic energy-momentum diagram for $GaAs_{1-x}P_x$ and discuss compositional dependence of the direct and indirect energy bandgap for $GaAs_{1-x}P_x$ system. What will be the lattice mismatch if GaP is grown on GaAs substrate? Given that: **(20)**

$$a_{GaAs} = 5.653\ \text{Å},\ a_{GaP} = 5.45\ \text{Å}$$

(b) Calculate effective bandgap for $Al_{0.7}Ga_{0.3}As$. Given that, **(15)**

$$E_g^{\Gamma}(x) = 1.425 + 1.247x \quad \text{(direct : } x \le 0.45)$$

$$= 1.425 + 1.247x + 1.147(x - 0.45)^2 \quad \text{(indirect : } x > 0.45)$$

$$E_g^{\chi}(x) = 1.9 + 0.125x + 0.143x^2$$

$$E_g^{L}(x) = 1.708 + 0.642x$$

Justify your answer.

2. (a) Show and explain typical absorption spectrum of a semiconductor over a large energy range. Discuss the changes in the spectrum if doping concentration is increased. What is penetration depth? **(20)**

(b) Explain polarization of an EM wave. What is birefringence? Draw and explain the operation of a transverse Pockels cell intensity modulator. **(15)**

3. (a) Compare the absorption and luminescence spectra of GaAs and doped GaP. Why extraction efficiency of an LED can be low in spite of high values of injection and radiative efficiencies? Compare properties of semiconductors used in confining and cladding layers of a DHLED. **(20)**

(b) The bandgap of GaAs at 300K is 1.43 eV, which changes with temperature as **(15)**

$$dEg/dT = -4.5 \times 10^{-4}\ eVK^{-1}$$

At 325K, what is the wavelength for peak emission? (Make necessary assumption).

4. (a) Draw equivalent circuit of a solar cell and explain the significance of elements used in the circuit. How does series resistance affect solar cell performance? What is its typical value? Discuss the factors those need to be considered to improve solar cell efficiency. **(20)**

(b) A solar cell under an illumination of 1000 W/m^2 has a short circuit current of 25 mA and open circuit voltage of 0.49 V. What are the short circuit current and open circuit voltages when area of the solar cell is doubled and illuminated light intensity is 1300 W/m^2? **(15)**

Contd P/2

SECTION – B

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

5. (a) What is optical gain lineshape? How the gain lineshapes of gas lasers and solid state lasers are broadened? **(10)**

(b) Describe how the cavity of a vertical cavity surface emitting laser is designed to get surface emission. **(12)**

(c) Effective mass of conduction electrons in GaAs is 0.07 m_e where m_e is the electron mass in vacuum. Calculate the first three electron energy levels for a GaAs quantum well of thickness 8 mm. What is the hole energy below E_v if the effective mass of the hole is 0.47 m_e? What is the change in the emission wavelength with respect to bulk GaAs, which has an energy bandgap of 1.42 eV? **(13)**

6. (a) Why population distribution of an atomic system has to be in non-equilibrium to make a lasers? **(8)**

(b) Derive expressions of steady-state population inversions in a three-level and four-level atomic systems in terms of the lifetimes and pumping rate. Explain why a four-level atomic system is efficient compared to a three-level atomic system. **(15)**

(c) Estimate the efficiency of a GaAs laser operating well above threshold, given that n = 3.6 and the wavelength of the laser cavity is 200 μm. Assume the loss coefficient to be 800 m^{-1} and the internal quantum efficiency to be 0.8. **(12)**

7. (a) How noise can be reduced in an avalanche photodiode using a staircase superlattice structure? **(10)**

(b) Find out the expressions of the external voltage and external current due to an incident light in a photodiode in photovoltaic and photoconductive modes, respectively. **(12)**

(c) Show that the responsivity of a photodiode can be expressed as **(13)**

$$R(f) = \frac{R(0)}{\left(1 + 4\pi^2 f^2 C^2 R_L^2\right)^{1/2}}$$

where C is the diode capacitance and R_L is the load resistance.

8. (a) Describe what limits the response time of a p-i-n photodiode. How the response time can be decreased? **(12)**

(b) If d is the thickness of a photodetector material, I_0 is the intensity of the incoming radiation, show that the number of photons absorbed per unit volume of sample is **(11)**

$$\eta_{ph} = \frac{I_0\left(1 - e^{-\alpha d}\right)}{dh\nu}$$

where symbols have their usual meanings.

(c) It is desired to make a silicon p-i-n photodiode of area 1 mm^2 with as fast a response time as possible when used in conjunction with a 50 Ω load resistor. Estimate the thickness of the intrinsic region required. Assume $\varepsilon_r = 11.8$ and the electron saturation velocity = 10^5 ms^{-1}. Over what wavelength range would you expect the device to be most effective? **(12)**

L-4/T-2/EEE Date : 30/01/2016

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

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**.

Symbols have their usual meanings.

1. (a) Why are standards necessary for telecommunication systems? **(5)**

(b) What is the name of the national standards body in Bangladesh? What are the functions of the body? **(8)**

(c) What are the functions of IEEE in developing telecommunication standards? **(7)**

(d) Why is hybrid 2W/4W necessary in telecommunication? **(5)**

(e) Suppose you live in Chittagong and your telephone subscriber number is 56 × 890. The area code for Chittagong is 031. What are the numbers that your friend who lives in UK need to be dialled to make a phone call to you? Does a person who lives in Mymensing can have the subscriber number 56 × 890? Explain. **(10)**

2. For the multi-stage switching system shown in Fig. for Q. 2, derive the expressions for **(5+5+10+15)**

(i) the total number of cross-points in terms of k, n and N,

(ii) the total number of cross-points for non-blocking in terms of n and N,

(iii) the optimum number of cross-points for non-blocking in terms of N, and

(iv) the blocking probability using Lee graph assuming that an inlet is busy with probability P.

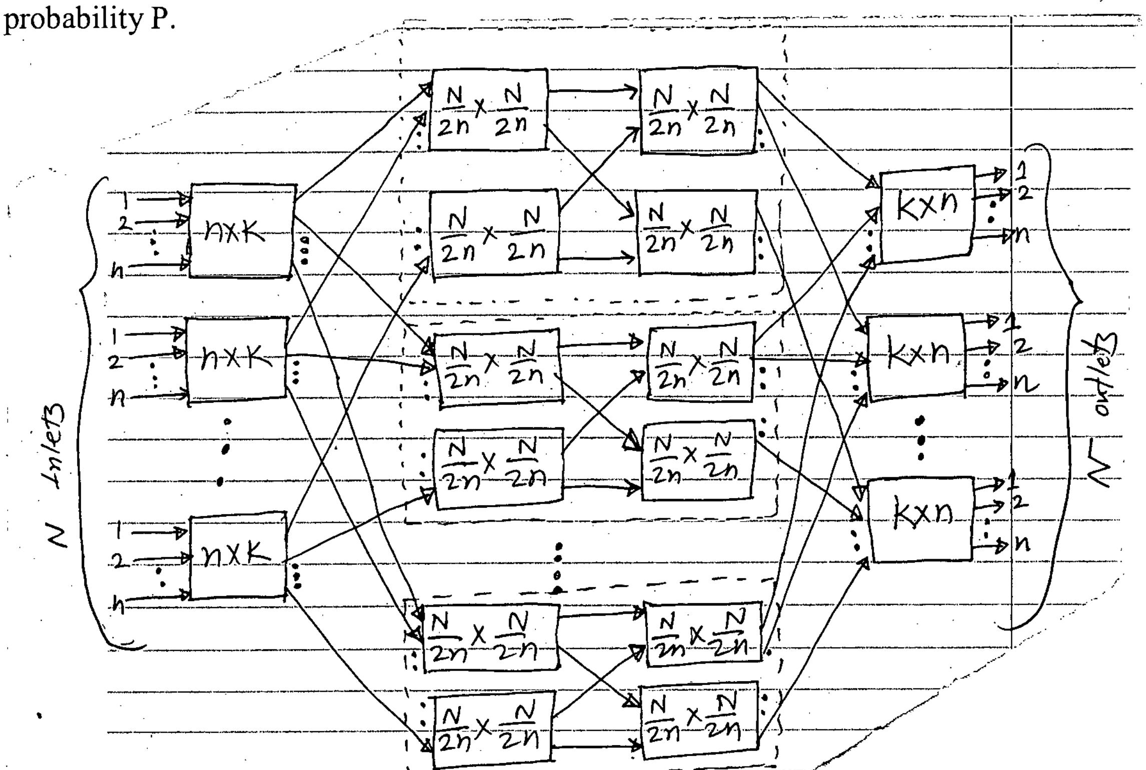

Fig. for Q. 2

Contd P/2

3. (a) What are the main advantages of multi-stage cross-bar switching as compared to the single stage cross-bar switching? **(8)**

(b) Which structure of multi-dimensional switching is the most common? Briefly describe its operation. **(12)**

(c) Consider a bufferless switching system with 30 subscribers and 2 lines. Each subscriber generates on the average 1 call in an hour and the average holding time of a call is 1 min. A subscriber's call return if the call is blocked. Approximately determine **(15)**

(i) the probability that all the lines are busy
(ii) the probability that all the lines are free
(iii) the probability that at least one line is free
(iv) utilization of the system.

4. (a) For a delay telecommunication system show that **(18)**

$$P(0)=\left[\sum_{k=0}^{N}\frac{A^k}{k!}+\frac{A^N}{N!}\cdot\frac{A}{N-A}\right]^{-1}$$

and the probability of waiting by a call is $\frac{BN}{N-A(1-B)}$.

(b) Consider a delay communication system with 15 subscribers. Each subscriber generates 2 calls in an hour and the average holding time of a call is 1 min. By increasing the number of lines determine the minimum number of required lines to achieve GOS less than 2 sec. Then, determine **(17)**

(i) the probability that 4 subscribers will call in 2 mins
(ii) the probability that 2 calls is served in 2 mins
(iii) the percentage of calls in the lines
(iv) the percentage of calls delayed less than 30 sec

SECTION – B

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

5. (a) What is ISDN? Discuss the architecture of a ISDN Reference model. **(10)**

(b) Discuss the different ISDN interfaces, channel and access rates along with their applications. **(15)**

(c) Show the ISDN protocol architecture and explain the functions of the lowest three layers at a UNI. **(10)**

Contd P/3

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6. (a) What is meant by VOIP and what types of protocols are used in Internet telephony and why? **(10)**

(b) What is meant by asynchronous transfer mode (ATM) switching? distinguish between virtual path identifier (VPI) and virtual channel identifier (VCI). How are VP and VC switching performed in an ATM switching network? **(10)**

(c) Discuss the different headers in an ATM cell. How are cells formatted at UNI and NNI? **(10)**

(d) What is LAPD? How is LAPD protocol utilized in an ATM reference model? **(5)**

7. (a) What is a satellite repeater? Draw the block diagram of satellite communications repeater and explain the functions carried out by each block. **(15)**

(b) What are the limiting factors that are considered in a satellite system design? How is the effect of rain mitigated? **(10)**

(c) A GEO satellite operating in Kn-band (14/12 GHz) is used in a earth-satellite link with following system parameters: **(10)**

Earth Station Parameters:

Antenna Aperture efficiency = 65%

Antenna diameter = 10 m

Transmitter power = 200 W

Signal : Compressed video signal at 560 Mbps.

Satellite Parameters:

Satellite antenna gain = 20 dB

Satellite receiver bandwidth = 560 MHz

Receiver noise temperature = 300 K

Slant range of satellite from earth station = 60,000 km

Atmospheric loss = 6 dB

Determine:

(i) Power received by the satellite receiver;

(ii) Carrier to noise ratio at the input of satellite receiver;

(iii) Path loss for uplink.

8. (a) Draw the architecture of a mobile cellular communication system and state the functions of VLR, HLR, BSC and MSC. **(15)**

(b) What are multipath fading, fast fading, slow fading, shadow fading and Doppler spread? Explain their effects on the communication system performance. **(10)**

(c) A mobile cellular communication system with hexagonal cell structure requires a minimum SIR of 23 dB in a location where path loss exponent is 3.5. Determine the value of frequency reuse factor. Draw the reuse pattern. **(10)**

L-4/T-2/EEE **Date : 30/01/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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.

All the symbols have their usual significance.

SECTION – A

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

1. (a) Explain vertically integrated grid, electricity market and smart grid. **(9)**

(b) How can electricity market operation be embedded in smart grid operation? **(5)**

(c) Explain the differences between primary and secondary control of system frequency? Show diagrams if needed. **(8)**

(d) Explain how the task of frequency control can be assigned to one or both of the two generators running in parallel. Show diagrams if needed. **(8)**

(e) Why does frequency fall immediately after system load increases? **(5)**

2. (a) Using an example explain how two DisCos (Distribution Companies) can benefit by price swap in an electricity market? **(12)**

(b) ISO receives the following offers and bids for a certain hour. Determine the market clearing price (MCP) and the social welfare (SW) for the hour showing the details of the calculation process. **(15+8)**

	Offers									Bids					
	G1			G1			G3			D1			D2		
Block	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
MW	5	12	13	8	8	9	10	10	5	14	14	14	13	13	13
\$/MWh	3	4.5	5.5	5	6	7	8	9	10	20	15	7	18	16	11

G: GenCo D: DisCo

Suppose there is no constraint on ramping limit and minimum power outputs of the units operated by GenCos.

3. (a) What do you mean by system security? Explain the four states in which the operation of a power system can be identified. **(5+10)**

(b) In a 5-bus, 3-generators and 6-lines system bus No. 5 is the slack generator connected bus. Each line can carry a maximum of 1000 MW. **(20)**

The sensitivity matrix $[S_f]$ is given as follows:

Contd P/2

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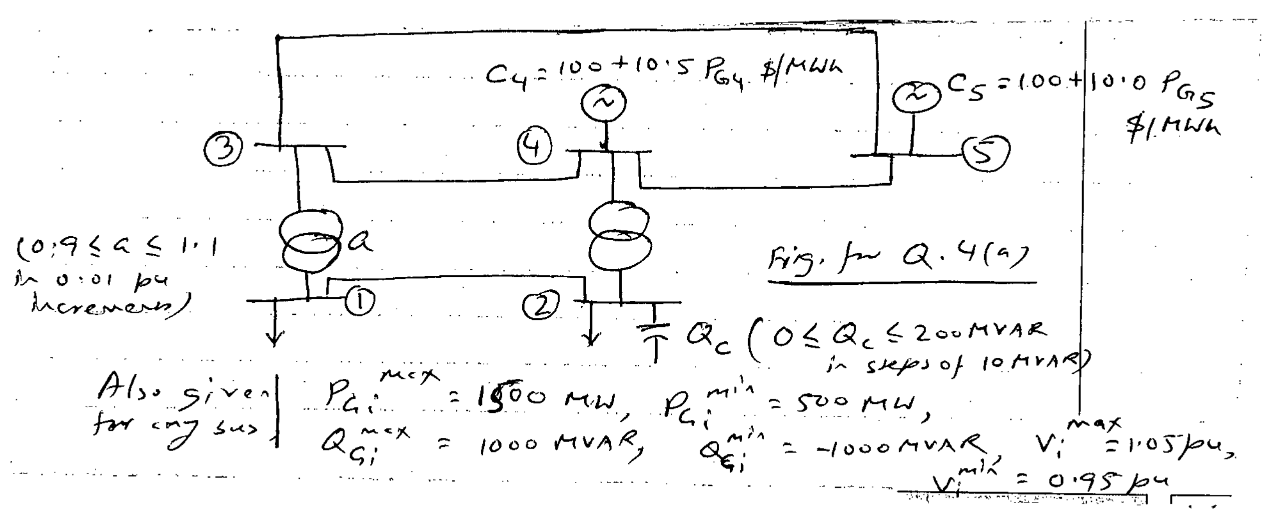
Contd... Q. No. 3(b)

$[S_f] =$

Line	Bus (1)	Bus (2)	Bus (3)	Bus (4)
1 – 2	0.4828	– 0.3448	0.4138	0.3448
1 – 3	0.1034	0.0689	– 0.4828	– 0.0689
1 – 4	0.4138	0.2759	0.0689	– 0.2759
2 – 5	0.4828	0.6652	0.4138	0.3448
3 – 4	0.1034	0.0689	0.5172	– 0.0689
4 – 5	0.5172	0.3448	0.5862	0.6552

Compute the ranking index (RI) for the system if the line 1–4 trips. The line flows prior to the trip were respectively 96, –699, –897, –404, 279 and 106 MW.

4. (a) For the system shown in Fig. formulate OPF (Optimal Power Flow) framework using full AC model and minimizing the generation costs as the objective function. Use symbols where numerical values are not available. Base value is 100 MVA. G and B matrices need not be calculated using numerical values. **(12)**



What would be the bus incremental costs for active power at bus 4 and 5?

(b) For the system shown in Fig. the line parameters and operating conditions are given in Tables 1 and 2. Suppose the outage of the line 1–3 causes severe overloads of some other lines. Using a DC model for the network equations formulate an SCOPF (securing constrained OPF). The objective function to be used is minimizing the cost of control actions. These actions comprise preventive redispatch of generators in pre-contingency state, corrective redispatch of generators in post-contingency state and shedding load in post-contingency state. Use suitable penalty cost in \$/MW for preventive redispatch, zero penalty cost for corrective redispatch and a large penalty cost in \$/MW for load shedding. Bus No. 5 is the slack bus. How can you ensure that preventive redispatch will be non-zero in the solution of an SCOPF? The X, A and B matrices need to be evaluated appropriately using the given diagram and Tables. **(23)**

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SECTION – B

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

5. (a) Why power system control is necessary for Bangladesh? **(5)**

   (b) Write short notes on 'IED' and 'PMU'. **(10)**

   (c) Briefly describe different components of EMS. **(20)**

6. Five ammeters numbered A_1 to A_5 are used in the dc circuit of Fig. for Q. No. 6 to determine the two unknown source currents I_1 and I_2. The standard deviations of the meter errors are 0.2 A for meters A_2 and A_5, and 0.1 A for the other three meters. The readings of the fiver meters are 0.12, 1.18, 3.7, 0.81 and 7.1 A, respectively.

   (a) Determine the weighted least-squares estimates of the soruce currents I_1 and I_2. Use the given [H] matrix. **(15)**

   (b) Using the chi-square test for α = 0.01, check for the presence of bad data in the measurements. Use the attached chi-square table. **(8)**

   (c) Eliminate any bad data detected in (b) and find the weighted least-squares estimates of the source currents using the reduced data set. **(12)**

$$H = \begin{bmatrix} 0.175 & -0.075 \\ -0.075 & 0.175 \\ 0.825 & 0.075 \\ 0.1 & 0.1 \\ 0.075 & 0.825 \end{bmatrix}$$

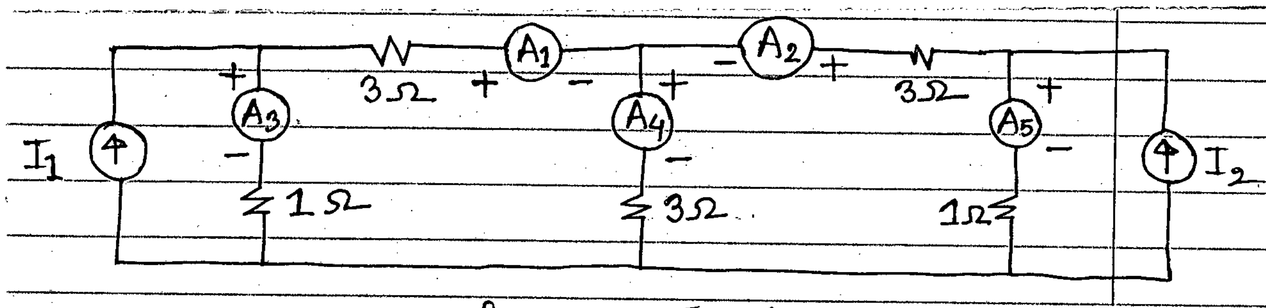

Fig. for Q. No. 6

Chi-square table for Q. No. 6

Values of area α to the right of $\chi^2 = \chi^2_{\kappa,\alpha}$

κ	α = 0.01
1	6.64
2	9.21
3	11.35
4	13.28
5	15.09

Contd P/4

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7. In a small power system there are two stages (each 4 hours long) in a load cycle and 4 generating units. In the last stage load is 1100 MW and in the first stage load is 1400 MW. Only units 1 and 2 are to operate in the last stage of load cycle.

   (a) Based on Table 1 and Table 2 for Q. No. 7 calculate the power supplied by generators if x_4 combination is used and the corresponding production cost in economically loading the units when the system is in the last stage. **(10)**

   (b) Assume that the start up cost of each thermal generating unit is \$3000 and shut down cost is \$1500, determine the optimal unit commitment policy of the four thermal units for the two stages. **(25)**

   The corresponding production cost in \$ for different combinations are:

   $P_1(1) = 58428$ $P_2(1) = 59356$ $P_3(1) = 58236$ $P_4(1) =$ infeasible

   $P_1(2) = 45848$ $P_2(2) = 45848$ $P_3(2) = 44792$ $P_4(2) = 45868$

Where, $P_m(n)$ = Production cost of combination X_m in the stage 'n' of the load cycle. Use the backward dynamic programming approach.

Table 1 (Q. No. 7): Possible unit combination

Unit No.	Combination			
	x_1	x_2	x_3	x_4
1	1	1	1	1
2	1	1	1	1
3	1	1	0	0
4	1	0	1	0

Table 2 (Q. No. 7): Unit technical and economic parameter

Generating Unit	Min (MW)	Max (MW)	a_i $/(MW)^{2}h	b_i W/MWh	c_i \$/h
1	100	625	0.008	8.0	500
2	100	625	0.0096	6.4	400
3	75	600	0.01	7.9	600
4	75	500	0.011	7.5	400

8. (a) Explain with a block diagram the computer-controlled AGC of a particular area in a power system. **(15)**

   (b) Three control areas with AGC system comprise the interconnected 50-Hz system of Fig. 8(b). The aggregate speed-droop characteristics and on-line generation capacities of the areas are;

   Area A: $R_{AU} = 0.02$ P.U.; $S_{RA} = 16{,}000$ MW

   Area B: $R_{BU} = 0.0125$ P.U.; $S_{RB} = 12{,}000$ MW

   Area C: $R_{CU} = 0.01$ P.U., $S_{RC} = 6{,}400$ MW

Contd P/5

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Contd... Q. No. 8(b)

For reason of economy area C is importing 500 MW of its load requirements from area B and 100 MW of its interchange passes over the tie-lines of area A, which has zero scheduled interchange of its own. The frequency bias setting of the areas are,

$$B_{fA} = -1200 \text{ MW/0.1 Hz}$$

$$B_{fB} = -1500 \text{ MW/0.1 Hz}$$

$$B_{fC} = -950 \text{ MW/0.1 Hz}$$

(i) Determine the frequency deviation and the generation changes of each area when a fully loaded 400 MW generator is forced out of service in area B. **(10)**

(ii) Determine the ACE of each area before AGC action begins. Use the formula: **(5)**

$$ACE = (P_{tie} - P_{tie},S) - 10B_f(f - f_s)$$

(iii) If the AGC action is delayed for 10 minutes find the difference between the system and standard time. **(5)**

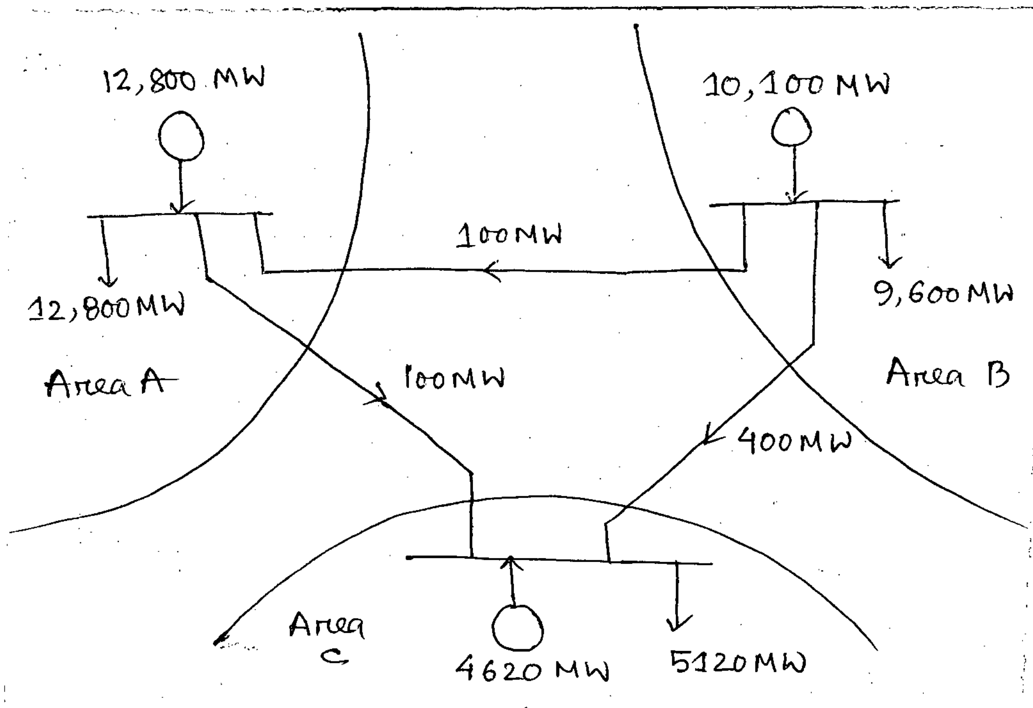

Fig. for Q. No. 8(b)

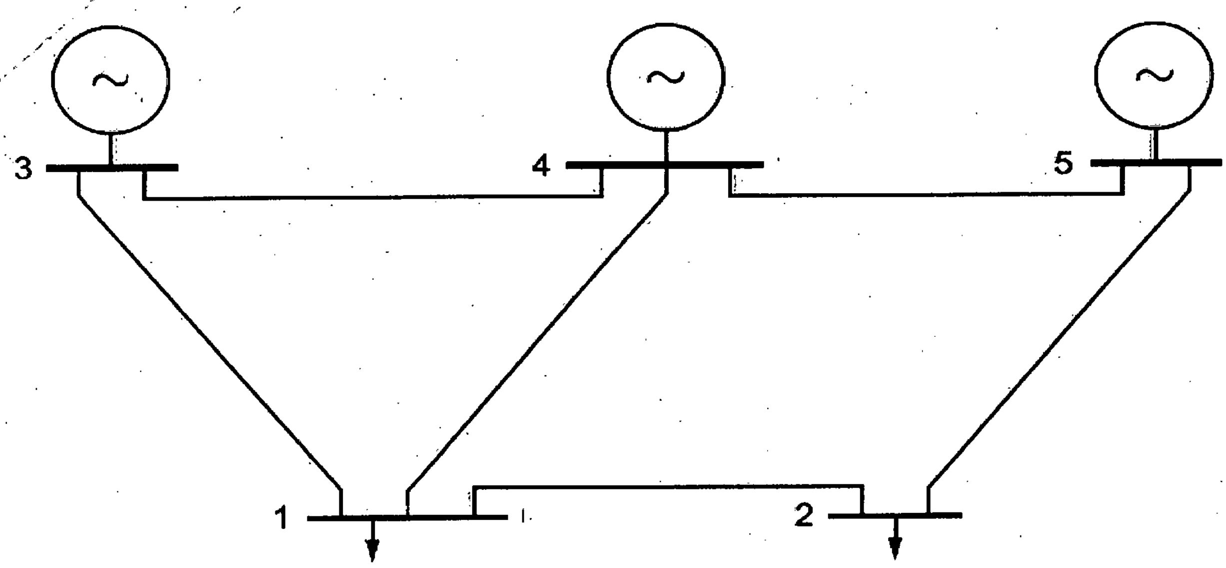

Fig. for Q. 4(b)

Table 1: Line parameters for Q. 4(b)

Line i, j	Reactance pu ($P_{base} = 100$ MVA)	P_f^{max} MW
L1 1-2	0.01	1000
L2 1-3	0.02	1000
L3 1-4	0.01	1000
L4 2-5	0.02	1000
L5 3-4	0.02	1000
L6 4-5	0.02	1000

Table 2 : Operating conditions for Q. 4(b)

Node	P_L MW	Q_L Mvar	P_G MW	P_G^{max} MW	P_G^{min} MW
1	1500	750	—	—	—
2	500	250	—	—	—
3	0	0	1000	1500	250
4	0	0	750	1500	250
5	0	0	309	1000	250

L-4/T-2/EEE **Date : 04/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

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) Define MHR and IHR. Describe various techniques to analyze HRV. **(10)**

   (b) With neat diagrams, discuss impedance changes of cardiac muscles due to ECG and blood flow. **(10)**

   (c) Explain the use of impedance plethysmograply to determine stroke volume. **(10)**

2. (a) Define Pacemakers. "Any portion of heart can be a pacemaker" – explain. Discuss the parameters of artificial pacemaker needed to be controlled for proper operation. **(15)**

   (b) Describe ventricular fibrillation and its cardio-respiratory consequences. What are its immediate treatments? **(10)**

   (c) Describe the operation of a defibrillator control circuit. **(10)**

3. (a) Name the factors that affect the genesis of ECG. Describe membrane and interference theorems to explain the origin of ECG. **(15)**

   (b) Describe the possible changes in ECG due to abnormality and explain the reasons. **(10)**

   (c) Describe bundle block in ECG. **(10)**

4. (a) Define cardiac cycle. Describe the relation of different events with ECG in the right portion of heart. What are the differences of events in left portion? **(15)**

   (b) Explain the significances of different potentials developed in a living cell. **(10)**

   (c) Define biometrics and describe its design factors. **(10)**

SECTION – B

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

5. (a) Briefly explain the function of RF coils in MR imaging. **(8)**

   (b) With neat diagram, describe the image formation in MRI. **(12)**

   (c) Explain the effects of attenuation and diffraction in ultrasound imaging. Describe different scanning modes of ultrasonography. **(15)**

Contd P/2

EEE 425

6. (a) What is the effect of the kV and mA ratings of an X-ray tube on **(8+7)**
   (i) the patient does, and
   (ii) the image quality?
   With neat block diagram, describe the image production by X-ray CT.
   (b) Define chemical and bacteriological tests of blood. **(8)**
   (c) Describe with necessary diagram the operation of an aperture impedance cell counter. **(12)**

7. (a) (i) Describe the exhibitory and inhibitory operation of a biological neuron. **(8)**
   (ii) Define different waves in EEG. Can EEG be used as a feature for detecting early seizure? Justify your answer. **(12)**
   (b) Classify noise that are normally present in biosignals. Describe the characteristics of noise in ECG due to technical origin. **(15)**

8. Write short notes on: **(12+12+11)**
   (i) ECG arrhythmia
   (ii) PET imaging
   (iii) Angiography

L-4/T-2/EEE **Date : 07/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) What are the main reasons for developing errors in results of numerical calculations? **(8)**

(b) Convert the decimal number 0.2 into binary equivalent upto 10 decimal places. **(4)**

(c) Derive the expression for the error in result of a division calculation of two numbers in terms of their own errors. Also, derive the general formula for relative error in the result of a numerical calculation. **(8+5)**

(d) Use 4-th order Taylor's series expression to approximate the function $f(x) = x^4 + \cos x$ from $x = 0$ and predict the function value at $h = \pi/8$. Also, calculate the percentage error in the predicted value. **(10)**

2. (a) Write down the steps of an algorithm to find the root of a non-linear equation using false-position method. **(8)**

(b) In finding the root of a non-linear equation using the Newton-Raphson method, if you cannot determine the value of $f'(x)$, what will you do to solve the problem? **(2)**

(c) Derive the expression for the next approximation of a root of the equation $f(x) = 0$ using Muller method. Once the new approximation of the root is obtained, mention which one of the previous three points should be discarded. **(12+3)**

(d) Determine the non-zero real root of the equation $x^3 - 5x^2 - 29 = 0$ between 5 and 6 using Secant method. Show calculations only for three successive approximations of the root. **(10)**

3. (a) What are pivots in solving system of linear equations? How will you handle if a pivot becomes zero at any stage of the solution? What are partial and complete pivotings? **(6)**

(b) Describe the Gauss-Seidel method to solve a linear system of equations. The associated algorithm should be described. **(12)**

(c) Solve the values of x_1, x_2, x_3 and x_4 for following four equations using the Gauss elimination method: **(8)**

$$\begin{aligned} x_1 + x_2 + 3x_4 &= 4 \\ 2x_1 + x_2 - x_3 + x_4 &= 1 \\ 3x_1 - x_2 - x_3 + 2x_4 &= -3 \\ -x_1 + 2x_2 + 3x_3 - x_4 &= 4 \end{aligned}$$

Contd P/2

EEE 423

4. (a) Express $\Delta^4 y_0$ interms of the ordinates. Hence, prove that, $\Delta^n y_0 = n\sum_{k=0}^{n}(-1)^k C_k y_{n-k}$

(b) Prove that, $\Delta = 1 - e^{-hD}$. **(9)**

(c) Prove that divided differences are symmetric functions of their arguments. **(8)**

(d) Construct a divided difference table for the values given below: **(10)**

x	1.0	1.3	1.6	1.9	2.2
f(x)	0.7651977	0.6200860	0.4554022	0.2818186	0.1103623

SECTION – B

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

5. (a) What are the differences between interpolation and curve fitting? In which cases will interpolation and least squares regression produce identical curves? **(8)**

(b) What are the advantages of spline interpolation over polynomial interpolation? State the properties of a natural cubic spline method. **(7)**

(c) Consider the following data table: **(20)**

x	−1	0	1	2
f(x)	−1	1	3	17

Estimate the value of f(1.5) using any suitable method of interpolation. If an additional data point (3, – 26) is added to the data table, what will be the new estimate of f(1.5)?

6. (a) Discuss the limitations of various probable criteria for fitting a "best" line through a given set of data points. What are the advantages of least square regression? **(13)**

(b) Derive the normal equations using least square regression to fit the equation z = ax + by + c through a set of data points (x_i, y_i, z_i) using least square regression, estimate the lifespan of an incandescent lamp at 30°C and 70% humidity from the following tabular data. **(22)**

Temperature (°C)	23	26	29	32	35
Humidity (%)	75	60	80	65	73
Life span (Hrs)	1200	1250	1350	1300	1180

7. (a) Estimate the missing value in the following table using an appropriate interpolation formula: **(20)**

x	2011	2012	2013	2014	2015
f(x)	76.6	78.2	-	77.7	78.7

(b) Evaluate the following using the Trapezoidal rule: **(15)**

$$\int_0^2\int_0^1 e^{x-y}\,dx\,dy \quad ; \quad \Delta x = \Delta y = 0.5$$

Contd P/3

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8. (a) Solve the following system of ODEs using Euler's Method: **(20)**

$$\frac{dy_1}{dx} = -0.5y_1 \quad , \quad y_1(0) = 4$$

$$\frac{dy_2}{dx} = 4 - 0.3y_2 - 0.1y_1 \quad , \quad y_2(0) = 6$$

Using a step size of 0.5, find the value of y_1 and y_2 at $x = 2$. **(15)**

(b) The distance travelled by a bus is given in the following table:

Time (in sec)	8.0	9.0	10.0	11.0	12.0
Distance (in km)	17.453	21.460	25.752	30.301	35.084

Estimate the velocity and acceleration at $t = 10$ sec. using the three-point finite difference formula for an accuracy of the order $O(n^2)$.

L-4/T-2/EEE **Date : 04/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2013-2014

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

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) Design an Ayrton Shunt to make an ammeter with current ranges of 10 mA, 100 mA and 500 mA for a meter movement having a full-scale deflection current of 1 mA and an internal resistance of 500 Ω. **(15)**

   (b) The voltmeter in the Fig. for Q. No. 1(b) uses a 1 mA meter movement with an internal resistance of 200 Ω. The shunt resistance R_{sh} across the movement is 400 Ω. Diodes D_1 and D_2 each has a forward resistance of 100 Ω, zero cut-in voltage and infinite reverse resistance.

   (i) Explain the function of the resistor R_{sh}. **(3)**

   (ii) Explain the function of the diode D_2. **(3)**

   (iii) Calculate the values of series resistor R_1, R_2 and R_3, if the required meter ranges are 50 V, 100 V and 200 V. **(9)**

   (iv) Determine the *sensitivity* of the AC voltmeter. **(5)**

2. (a) When connected in the circuit, as shown in the Fig. for Q. No. 2(a), a meter having a sensitivity of 100 Ω/V reads 4.65 V on its 50V scale. Calculate the value of R_x. **(10)**

   (b) A half-wave-rectifier-based AC voltmeter having a 100-μA meter movement is used in its 15 V range to measure voltage V_0, as shown in the Fig. for Q. No. 2(b). What is the minimum voltage that should be observed, if the meter accuracy is ± 5% *fsd*? **(13)**

   (c) Derive the expression for the output analog voltage of n-bit R-2R ladder type DAC. **(12)**

3. (a) What are the advantages and disadvantages of single-phase induction type energy meters? **(8)**

   (b) Draw the equivalent circuit and phasor diagram of a CT and derive the expression for its *Ratio Error*. **(15)**

   (c) A bar-type CT with a nominal ratio of 500/5 has a secondary resistance of 0.5 Ω and negligible secondary reactance. The resultant of magnetizing and iron loss components of the primary current associated with a full-load secondary current of 5 A in a burden of 1.0 Ω (non-inductive) is 3 A at a power factor of 0.4. Calculate the true *Ratio Error* of the CT on full-load. **(12)**

Contd P/2

EEE 427

4. (a) For the variable reluctance type transducer arrangement, shown in the Fig. for Q. No. 4(a), show that its inductance is inversely proportional to the air-gap length. **(15)**

(b) A capacitive displacement-type transducer arrangement is shown in the Fig. for Q. No. 4(b). It consists of four parallel plates separated by air. Plates A, C and D are fixed and plane B can be moved. Plate B has a thickness of t and is at distance d from plates on either side. Plates B, C, D are all of length l, while plate A has a length $2l$. All plates have a width w. The gap between plates C and D can be considered as negligible. Neglecting the end-effects, derive expression for capacitance C_{AC} and C_{AD} for movement of the midpoint of plate B between $x = \pm l/2$. $x = 0$ is the position of symmetry. **(20)**

SECTION – B

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

5. (a) Explain, with neat sketches, the working principle of a PMT (photo multiplier tube). **(15)**

(b) Write a short note on 'Capacitive Pressure Transducers'. **(10)**

(c) Briefly explain the working principle of an ultrasonic flowmeter and derive its operating equation. **(10)**

6. (a) What are the desirable characteristics of an amplifier to be used in an instrumentation circuit? **(5)**

(b) What is an Instrumentation Amplifier? What are its advantages? Derive its gain equation. **(15)**

(c) Explain how noise can be coupled inductively into a measurement system? What are the possible solutions to this type of interference? **(15)**

7. (a) Write a short note on 'Time-of-flight method for measurement of liquid level'. **(8)**

(b) Draw the schematic diagram of a Ramp AD converter and explain its operation. **(12)**

(c) What are the response parameters of a "sample and hold" circuit? Define and show them in a neat sketch. **(9)**

(d) What is the main advantage of using ternary materials for LED displays? Explain briefly. **(6)**

8. (a) What are the problems of measuring low resistances by using a Wheatstone Bridge? How these problems can be overcome by using Kelvin Double Bridge? Derive operating equation for Kelvin Double Bridge. **(15)**

(b) What is base-band telemetry? Explain briefly, with neat sketches, each type of base-band telemetry. **(15)**

(c) Draw the block diagram of a Data Acquisition System. **(5)**

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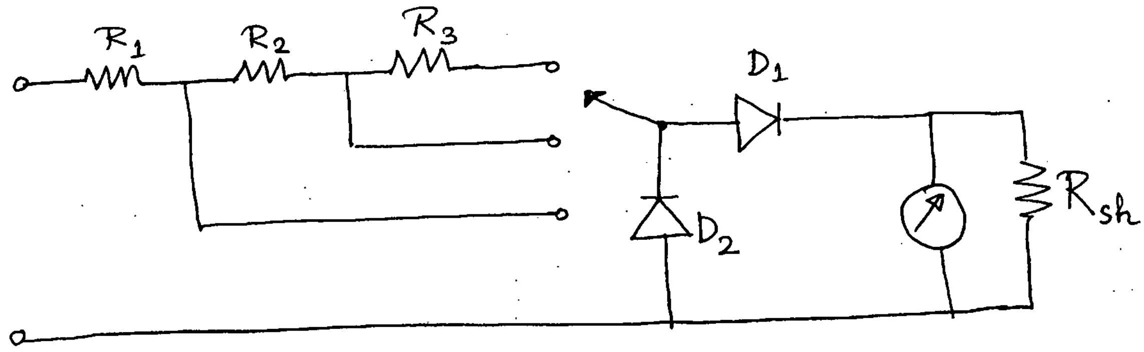
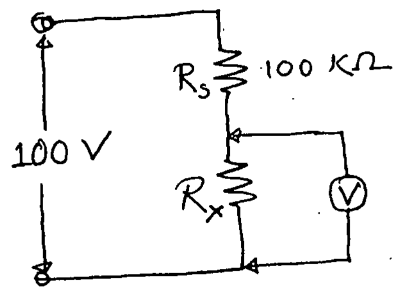


Fig. for Q. No. 1(b)



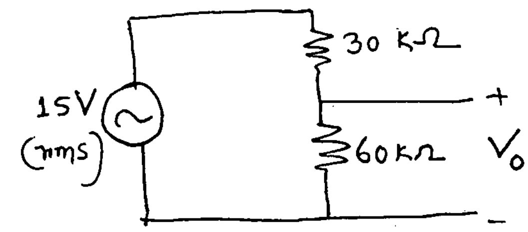


Fig. for Q. NO. 2(a)

Fig. for Q. NO. 2(b)

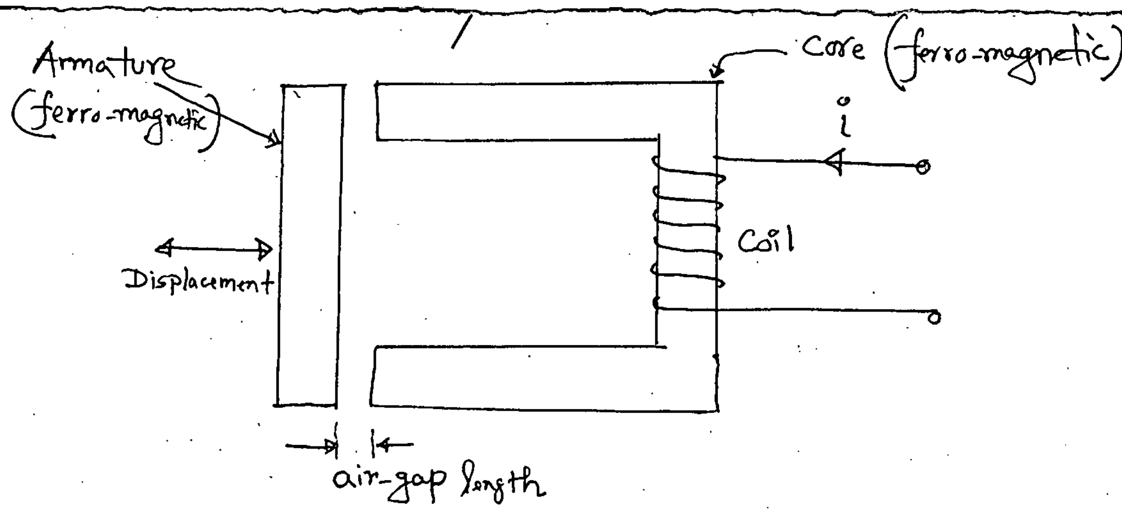


Fig. for Q. No. 4(a)

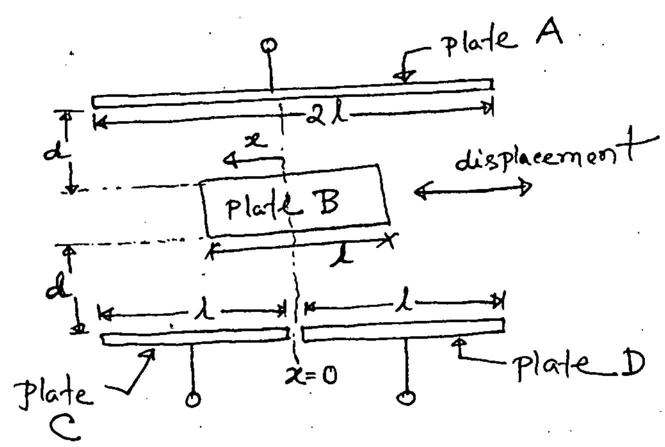


Fig. for Q. No. 4(b)

L-4/T-1/EEE **Date : 02/02/2016**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2013-2014

Sub : **EEE 433** (Microwave Engineering)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meaning.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Use Smith charts if necessary. Attach the used Smith Charts with your answer script.

Symbols have their usual meanings.

1. (a) Deduce telegrapher equations and find their steady state solution. **(10)**

(b) For an ideally lossless transmission line determine its current and voltage equations, reflection co-efficient, voltage standing wave ratio, phase constant and input impedance in terms of line parameters. **(12)**

(c) A microwave line of length 10.2 λ is terminated by a load. The characteristic impedance of the line is 50 Ω and a voltage minimum is observed at 0.06 λ from the load towards generator. Find the load impedance and the input impedance, if the VSWR is 1.5. [Use Smith's Chart] **(13)**

2. (a) Design a double-stub shunt tuner to match a load impedance Z_L = 60-j80 Ω line. The stubs are to be open circuited and spaced $\lambda/8$ apart. **(12)**

(b) The following two-step procedure has been carried out with a 50 Ω coaxial slotted line to determine an unknown load impedance. **(13)**

(i) A short circuit is placed at the load plane, resulting in a standing wave on the line with infinite SWR and sharply defined voltage minima. On the arbitrarily positioned scale on the slotted line the voltage minima are z = 0.2 cm, 2.2 cm, 4.2 cm

(ii) The short circuit is removed and replaced with the unknown load. The SWR is 1.5 and voltage minima are z = 0.72 cm, 2.72 cm, 4.72 cm

Find the load impedance.

(c) Write a short note on a Quarter Wave Transformer. **(10)**

3. (a) Find general solutions (field quantities) to Maxwell's equations for TM wave propagation in waveguides. **(12)**

(b) Analytically deduce the expression of cutoff frequency of the lowest-order TM mode to propagate in a rectangular waveguide [Use the results of Q. 3(a)]. **(13)**

(c) A rectangular air-filled copper waveguide with a 0.9 inch × 0.4 inch cross-section and 12 inch length is opened at 9.2 GHz with a dominant mode. Find: (i) cutoff frequency (ii) guide wavelength, (iii) phase velocity, (iv) characteristic impedance. **(10)**

Contd P/2

EEE 433

4. (a) What is a surface wave? Derive the expressions of field solutions for a TM surface wave on a grounded dielectric slab. **(18)**

(b) Sketch the field lines along xy, yz and zx planes for TEM wave in a parallel plate waveguide assuming that electric field is y-polarized. **(10)**

(c) How can you make an inductance at a Microwave frequency using a piece of transmission line? **(7)**

SECTION – B

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

5. (a) Derive the resonant frequencies for a general TE or TM resonant mode of a rectangular cavity, and then derive an expression for the unloaded Q of the $TE_{10\ell}$ mode. **(20)**

(b) A rectangular waveguide cavity is made from a piece of copper WR-187 H-band waveguide, with a = 4.755 cm and b = 2.215 cm. The cavity is filled with polyethylene ($\varepsilon_r = 2.25$, $\tan\delta = 0.004$). If resonance is to occur at f = 5 GHz, find the required length, d, and the resulting unloaded Q for the l = 1 and l = 2 resonant modes. The surface resistivity of copper at 5GHz is $1.84 \times 10^{-2}\ \Omega$. **(15)**

6. (a) Deduce the analytical expressions for the components of the electric and magnetic fields and the average power radiation per unit area of a half-wave dipole antenna. **(20)**

(b) An electric dipole of length 50 cm is situated in free space. If the maximum value of the current is 25 A and its frequency is 10 MHz, determine- **(15)**

(i) the electric and magnetic fields in the far zone, (ii) the average power density,

(iii) the radiation resistance.

7. (a) The radiation intensity of a lossless antenna is given by- **(15)**

$$U(\theta) = \begin{cases} B\cos^2\theta & , \quad 0 \le \theta \le \pi/2 \\ 0 & , \quad \pi/2 \le \theta \le \pi \end{cases}$$

The power radiated by the antenna at a frequency of 10 GHz is 10 W.

(i) Find the value of B, (ii) Calculate HPBW and FNBW,

(iii) Calculate its maximum gain and maximum effective aperture.

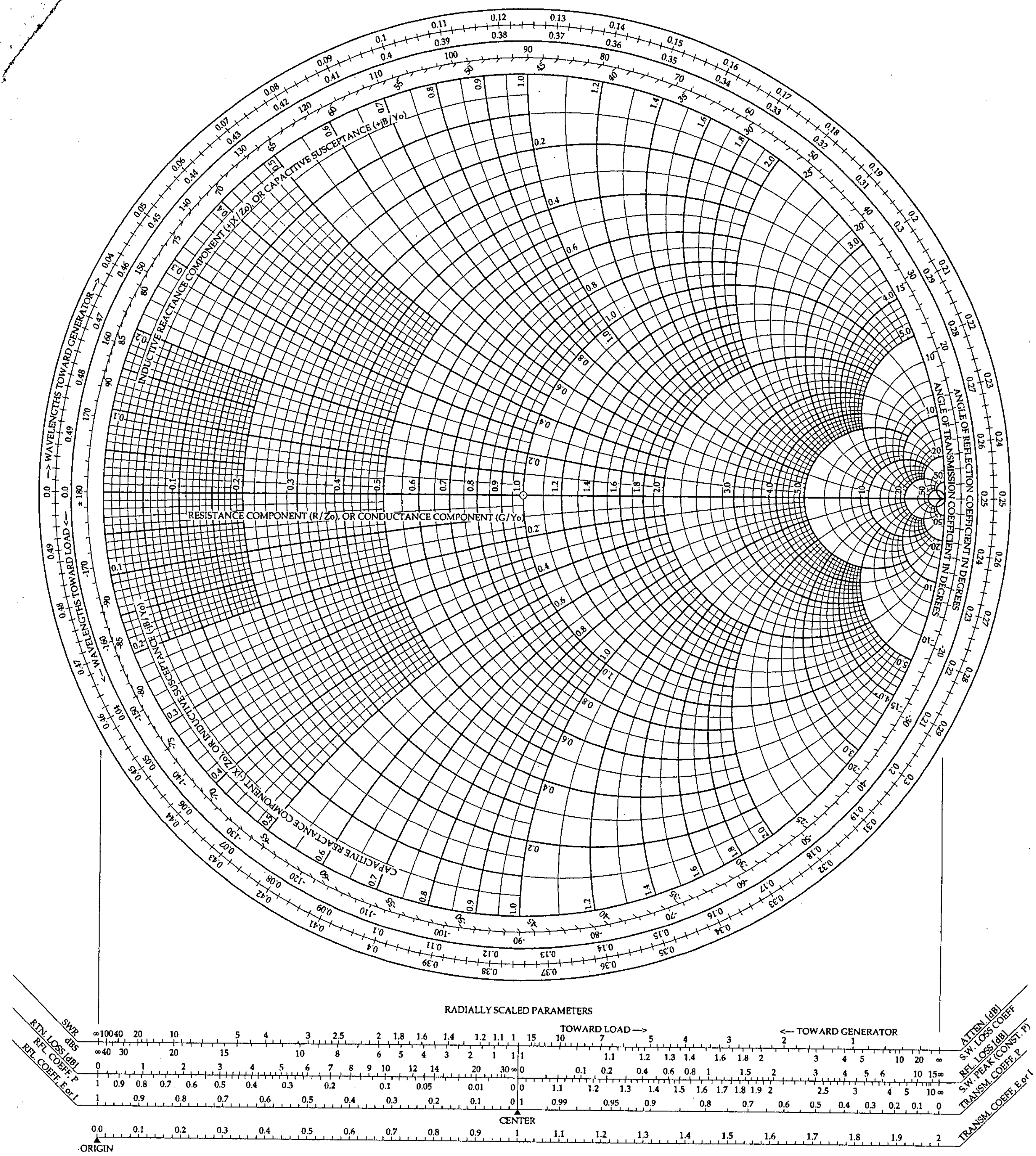
(b) Derive Frii's power transmission formula and radar range equation. **(20)**

8. (a) What are the purposes of arraying antenna elements? Derive the properties of an endfire array. **(20)**

(b) Design a 10 element broad side array that has a first null bandwidth of 30°. Roughly sketch the polar plot of array factor clearly showing the nulls, major lobe and minor lobes. **(15)**

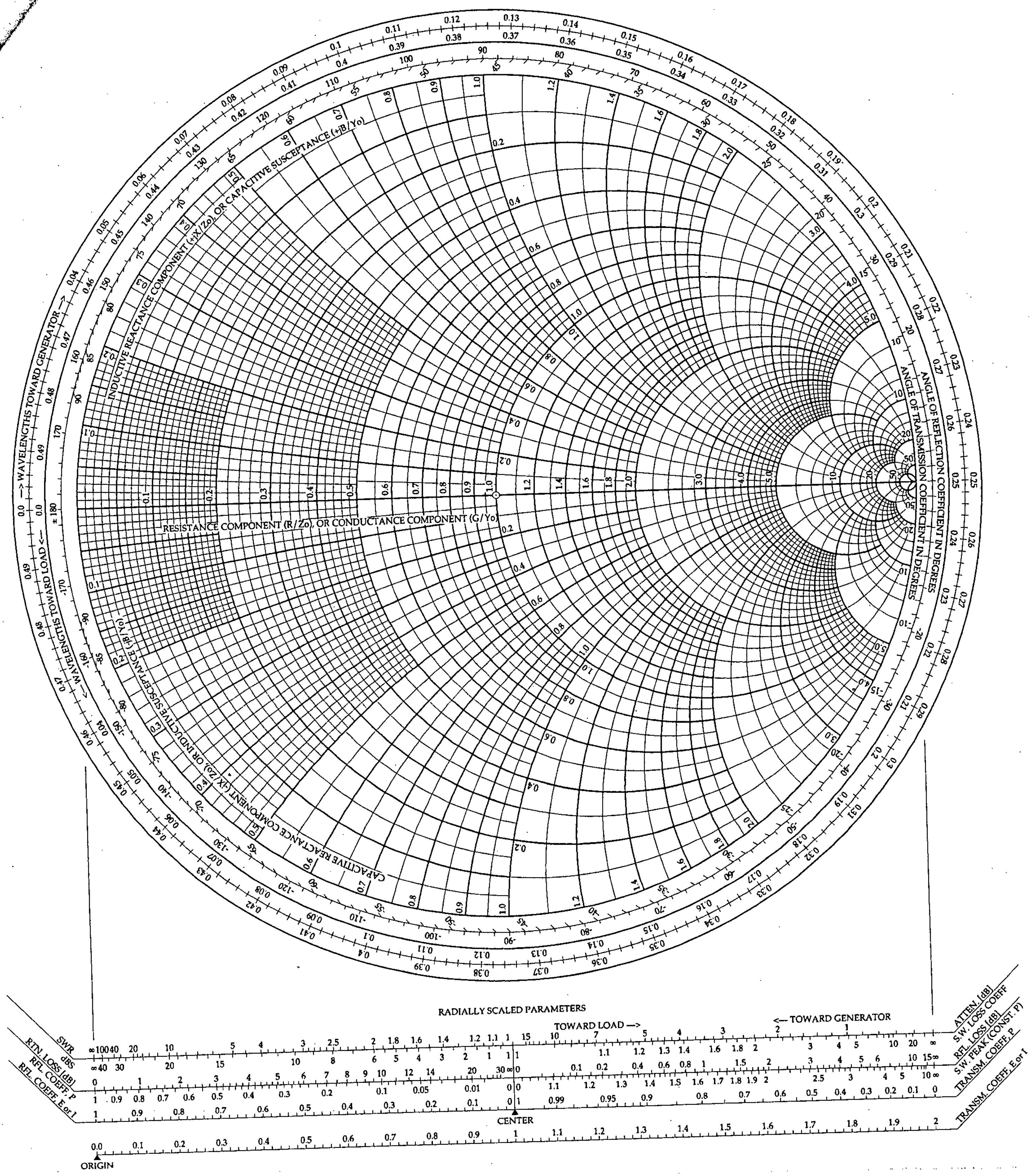
The Complete Smith Chart

Black Magic Design



The Complete Smith Chart

Black Magic Design



The Complete Smith Chart

Black Magic Design