L-4/T-2/EEE **Date : 01/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examinations 2016-2017

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

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**.

Make reasonable assumption for missing parameter. The symbols have their usual meaning.

1. (a) You have to design a 64-bit adder. Calculate the minimum computation time required by the adder if (i) Ripple carry adder (ii) Carry select adder and (iii) Carry skip adder is used. 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. **(15)**

   (b) Sketch the partial products used by a radix-4 Booth-encoded multiplier to compute $(13)_{10} \times (8)_{10}$ and show the generation of the corresponding final products. Design a Booth encoder using Xi, X2i, and Mi where Xi is true for $\pm Y$, X2i is true for $\pm 2Y$, and Mi is true for negative partial products. Also design a selector circuit using this encoding where X is the multiplier and Y is the multiplicand. **(20)**

2. (a) Show the Register Transfer Level (RTL) synthesis flow of a typical ASIC design. **(10)**

   (b) Explain where the following file systems are used in Standard Cell Place and Route (PnR) flow: (i) LEF (ii) Library SDF? **(5)**

   (c) Design a flip-flop with asynchronous set and reset and explain its operation. **(10)**

   (d) In a flip-flop based sequencing style of static circuit the following data are given: **(10)**

	t_{pcq}	t_{ccq}	t_{setup}	t_{hold}	t_{skew}	T_{cycle}
Flip-flop	50 ps	35 ps	65 ps	30 ps	3 ps	500 ps

   Find the maximum logic propagation delay and the minimum logic contamination delay available.

3. (a) Table below shows 3-bit Gray codes representing the numbers 0 to7 which has a useful property in that consecutive numbers differ in only a single bit position. Design a 3- bit modulo 8 Gray code counter FSM with no inputs and three outputs. When reset, the output should be 000. On each clock edge, the output should advance to the next Gray code. After reaching 100, it should repeat with 000. Show the state transition diagram, state transition table and the hardware for the Gray code counter FSM. **(15)**

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<u>Contd... Q. No. 3 (a)</u>

Number	Gray Code
0	0 0 0
1	0 0 1
2	0 1 1
3	0 1 0
4	1 1 0
5	1 1 1
6	1 0 1
7	1 0 0

Table for Q. 3(a)

(b) Write a system Verilog module of the state machine described in 3(a). Also write a test bench to verify the functionality of your module. **(20)**

4. (a) With a reference to Static Timing Analysis (STA) explain the following terms: (i) Clock latency, (ii) Clock skew, (iii) Slack of a path (iv) False path. **(8)**

(b) STA is performed on the circuit shown below which has a clock period of 25 ns. Show details calculations performed by the STA engine and show the setup slack and hold slack. **(20)**

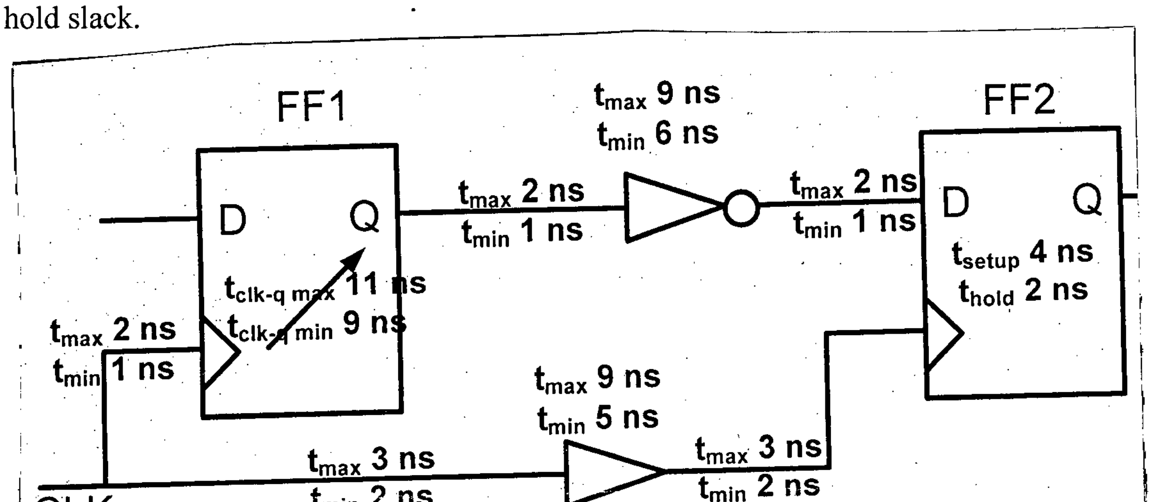

Fig. for Q. 4(b)

(c) Estimate maximum clock frequency at which the circuit in part 4(b) can operate. **(7)**

SECTION-B

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

5. (a) Prove that for the minimum-size repeaters to be useful for improving wire delay, the RC constant of the wire must be at least seven times the delay of a minimum-size buffer. Show details of your calculations. **(18)**

(b) Design the architecture of a 4 by 4 bit NOR ROM which stores the data mentioned in the Table for Q. 5(a). Also, redesign the architecture using a NAND ROM structure and mention its benefits over the NOR ROM unit. **(17)**

Contd P/3

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

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

Table for Q. 5(a)

6. (a) The Figure for Q. 6(a) shows a multistage logic network built with different types of gates. Estimate the minimum delay of the path from A to B and choose transistor sizes to achieve this effect. **(20)**

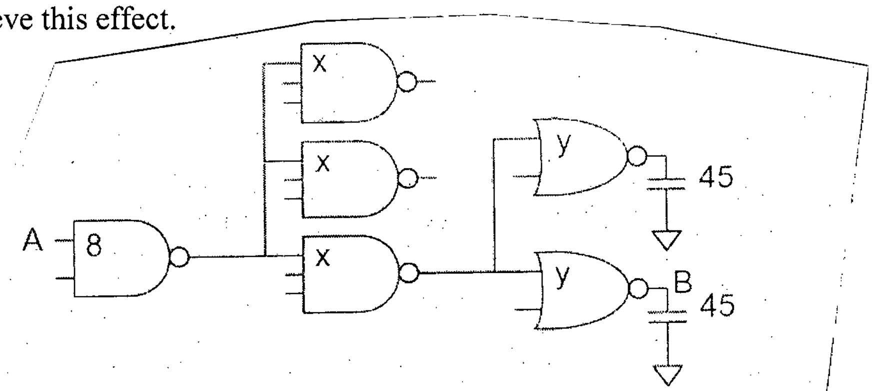

Figure for Q. 6(a)

(b) Assume that while using a CMOS process, constant field scaling is followed by silicon devices and ideal scaling is adopted by global interconnect elements. With diagrams, calculate the scaling patterns of device on resistance and interconnection resistance. **(15)**

7. (a) Explain the write and read operations of 6 transistor CMOS SRAM memory cell and discuss the significance of including sense amplifier blocks in the architecture. **(18)**

(b) Consider a 1.2 billion transistor chip built on a 0.9 V 65 nm process which contains 120 M logic transistors. The rest of the devices are memory transistors. The average width of logic transistors is 10λ and their activity factor is 0.1. In case of memory transistors these parameters are 3λ and 0.03, respectively. High Vt devices are used in all the cases and they have a gate capacitance of 0.8 fF/μm and diffusion capacitance of 0.5 fF/μm. The subthreshold leakage for normal Vt devices is 100 nA/μm and hight Vt devices is 10 nA/μm. Gate leakage for all devices is 6 nA/μm. Estimate the chip's dynamic power consumption at 1.2 GHz. State the necessary assumptions for the calculation. **(17)**

8. (a) Write short notes on the following topics related to CMOS process flow: (i) LPCVD, (ii) STI, (iii) CMP, (iv) Tungsten LI. Also, explain the necessity of lightly doped implants in an advanced process flow. **(18)**

(b) Realize a XOR function and its complement using cascode voltage switch logic. Mention the benefits of this logic over other circuit families. Explain how the logical effort of NAND2 gates is affected by the use of footed and unfooted dynamic circuits. **(17)**

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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2017-2018

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) Present a list of actuating quantities and criteria for detecting power system faults. **(6)**

(b) Identify the primary protection zones of the system shown in Fig. for Q. 1(b). Explain why adjacent primary protective zones overlap around a circuit breaker. Identify the backup protection breakers for station K, line EF and line BD, respectively? **(11)**

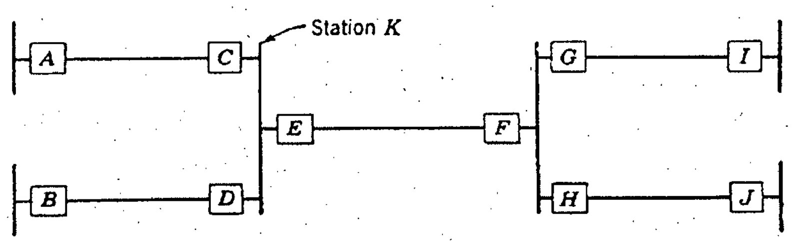

Fig. for Q. 1(b)

(c) Consider the small power system having primary and back-up protective relays, and the cases involving breaker trips. For each case, a short circuit has occurred and certain CBs have tripped. Assume that tripping of breakers was correct. Where was the short circuit? Was there any failure of relaying, including breakers, and if so, what failed? **(18)**

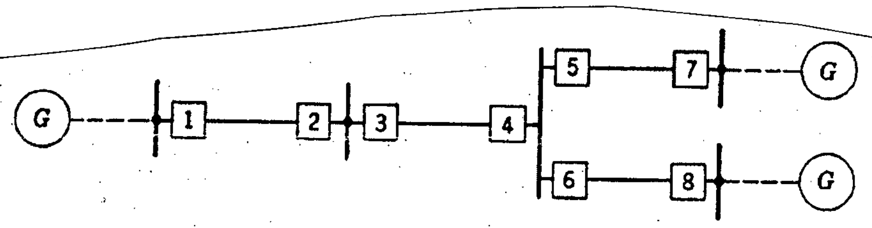

Fig. for Q. 1(c)

Case	Breakers tripped
a	4,5,8
b	3,7,8
c	3,4,5,6
d	1,4,5,6
e	4,5,7,8
f	4,5,6

Contd P/2

2. (a) Describe the construction of an induction disc relay and its principle of operation. How can you produce under- or overvoltage relays using an induction disc-type relay? **(15)**

(b) What are the advantages of induction relays? How is the current setting and time setting obtained? What technique would you adopt for an electromechanical relay to address the problem of transients or noise in input signals? **(12)**

(c) Why distance relaying is better than simple overcurrent relaying? Why inverse time characteristic is included in overcurrent- and distance relays? **(8)**

3. (a) Present the operating principle of biased or percentage differential protection. Why it is superior to simple differential protection. **(10)**

(b) Present the trip laws for different types of impedance relays. **(9)**

(c) What are the effects of arc resistance on the reach of impedance-, reactance- and mho-relays? **(6)**

(d) Why bus protection by overcurrent relays of other zones is not a satisfactory solution? Explain the high impedance differential protection principle for bus zone protection. **(10)**

4. (a) Present a simplified scheme for a solid-state mho relay. Include relevant vector diagrams and waveshapes. **(12)**

(b) Discuss the problems of providing distance protection to a three-phase line. **(8)**

(c) Explain how ground fault is detected in distance protection scheme. **(9)**

(d) Draw and explain the trip contact configuration for three-stepped distance protection. **(6)**

SECTION – B

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

All the abbreviations have their usual significance.

5. (a) Explain with diagrams the problems of disconnecting a transformer on no-load. **(10)**

(b) In a 132 kV 45 MVA 50 Hz transformer the magnetizing current is approximately 2% of its rated current and the phase to ground capacitance is 0.01 μF. Calculate the value of the resistance to be used in parallel with the CB. **(5)**

(c) Discuss using diagrams where necessary at least 10 major specifications of a HV circuit breaker. **(20)**

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6. (a) Describe briefly the arc extinction principles in oil, vacuum, air blast and SF_6 circuit breakers. **(12)**

(b) What is arc time constant? Why is a SF6 breaker small in size? Why resistance switching is not needed in SF_6 breakers? **(6)**

(c) Explain what do you mean by GIS. What are the advantages and disadvantages of SF_6 CB? Mention the main constructional features of SF_6 CB. **(17)**

7. (a) Mention in a tabular form the various abnormal conditions likely to arise in a power transformer and their corresponding protection systems. **(10)**

(b) Mention in a tabular form the various abnormal conditions likely to arise in a generator, their effects and corresponding protection systems. **(15)**

(c) The neutral point of a 10 kV alternator is earthed through a 10 ohms resistor. A restricted earth fault differential protection system used for the alternator has CTs with ratio of 200/5 and a relay that operates for an out of balance current of 1 Amp in CT secondary. Calculate the percentage of each phase winding protected. If 90% of each phase winding is to be protected calculate the resistor to be used in neutral to ground. **(10)**

8. (a) Derive an expression for the ratio correction factor (R) of a CT using necessary diagrams. **(10)**

(b) Calculate the ratio correction factor of a CT for (i) a burden of 2+j0 ohms and (ii) a burden of 0+j2 ohms. The CT has a turns ratio of 500:5, a magnetizing impedance of 4+j15 ohms and a secondary leakage impedance of 0.01+j0.1 ohms. **(10)**

(c) Explain the basic principle of a CCVT and also explain how phase angle error and ferroresonance may be suppressed? **(15)**

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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

All Symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Prove the followings- **(18)**

   (i) $L \geq H_D(X)$,

   (ii) $H_D(X) \leq L^* < H_D(X) + 1$, where all symbols have their usual meanings.

   (b) 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. Construct an optimal code following Huffman algorithm and compute L*. Verify part (a)'s theorems. **(17)**

2. (a) For a (6,3) systematic linear block code of the form ($P_1P_2P_3D_1D_2D_3$), the three parity check digits P_1, P_2, P_3 are $P_1 = D_1 \oplus D_2 \oplus D_3$, $P_2 = D_1 \oplus D_2$, $P_3 = D_1 \oplus D_3$. (i) Construct the appropriate generator matrix for this code. (ii) Construct the input-output table for the coder. (iii) Determine the error correcting capability of this code (iv) Determine H. (v) Prepare the syndrome table (vi) Decode the following received codewords- 101100, 000110, 101010. **(18)**

   (b) Given a random process $x(t) = A\cos(w_c t + \theta)$, where θ is a Random Variable (RV) uniformly distributed in the range $(0, 2\pi)$. (i) sketch the ensemble of this process. (ii) Determine $x(t)$, $R_x(t_1, t_2)$. (iii) Is the process WSS? If yes, compute power of the process. (iv) Is the process ergodic? Justify your answer. **(17)**

3. (a) Define Q(·) function. Now compute the cumulative distribution function of a general Gaussian density function in terms of Q(·) function. **(17)**

   (b) An M-signal configuration in a two-dimensional space is shown in the figure for Q. No. 3(b). How may basis functions are required? In the signal space, sketch the optimum decision regions, assuming an AWGN channel. Determine the error probability P_{eM} of the optimum receiver as a function of E_b. [Assume signals are equiprobable] **(18)**

Contd P/2

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4. (a) Write down the general equations of signals for 16-ary PSK. Determine the orthonormal basis functions for the signals using Gram-Schmidt orthogonalization procedure. **(17)**

(b) A source emits eight equiprobable messages which are assigned QAM signals $S_1, S_2, \cdots, S_8$, as shown in the figure for Q. No. 4(b). How many basis functions are required? Determine and sketch the optimum decision regions assuming an AWGN channel. Also determine the error probability P_{eM} of the optimum receiver as a function of E_b. **(18)**

SECTION – B

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

Answer in brief and to the point. Make reasonable assumptions on any missing information.

5. (a) (i) Explain one of the major advantages of digital communication systems over their analog counterparts. **(18)**

(ii) Define transparent line code with example. Is it a desirable property of a line code? If yes, explain why.

(iii) Draw the power density plot of ASK, PSK and FSK schemes. Also comment on their bandwidth requirement.

(b) In a certain telemetry system, there are eight analog measurements, each of bandwidth 2 kHz. Samples of this signals are time division multiplexed, quantized to 256 levels and then binary coded. Find the transmission bandwidth B_T if Nyquist criterion pulse with roll off r = 0.3 is used. The sampling rate must be at least 20% above the Nyquist rate. **(17)**

6. (a) Consider the convolutional coder with n = 3, k = 1, K = 3. Connection representation of the coder is given as g_1 = (101), g_2 = (111) and g_3 = (011). The coded output is $g_1g_2g_3$. **(18)**

(i) Describe this code using a Trellis diagram.

(ii) Determine the coded output for 1011.

(iii) Calculate d_{free} and bit correction capability for this coder.

(iv) How is bit correction capability related to K?

(b) Briefly explain the underlying principle for Trellis coded modulation. Complete the coded modulation for the channel coder as shown in Fig. for Q. No. 6(b) considering 8-PSK modulation. **(17)**

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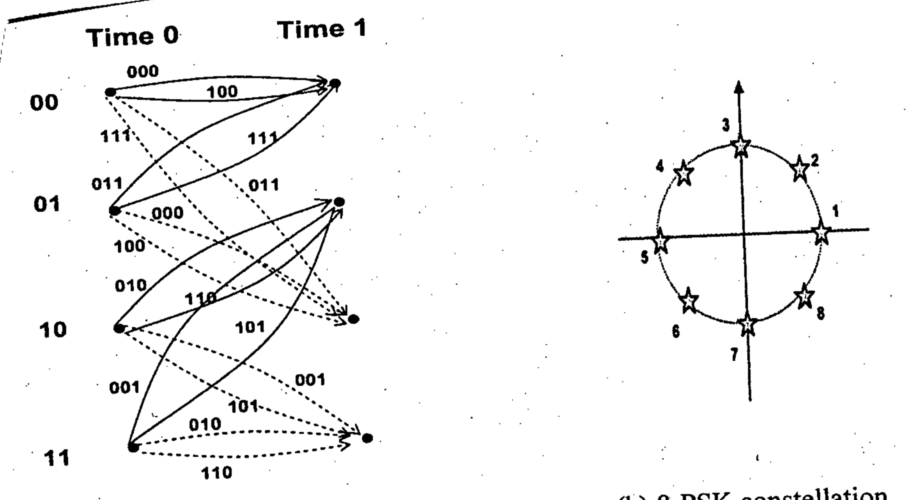
Contd... Q. No. 6(b)



(a) Trellis diagram for the coder

(b) 8-PSK constellation

Fig. for Q. No. 6(b)

7. (a) In a binary data transmission using duobinary pulses, sample values of the received pulses are as follows. **(18)**

   1 2 0 0 0 -2 0 0 -2 0 2 0 0 -2 0 2 2 0 -2

   (i) Find if there is any error in the received pulses.

   (ii) Write down the correct transmitted bit sequence. Note that if more than one sequence is possible, write down as many as you can. Assume that more than one detection error is extremely unlikely.

   (b) What is the advantage of differential PSK scheme? Draw its transmitter and receiver. Explain their operations. **(17)**

8. (a) Consider an AWGN channel with noise level $N = 10^{-13}$ W/Hz. A user signal is binary FSK modulated with data rate 18 kbps occupying a bandwidth of 22 kHz. The received signal power is –20 dBm. An enemy has a jamming source that can jam either a narrowband or a broadband signal. The jamming power is finite such that the local received jamming signal power is at most –28 dBm. Assuming a spreading factor L = 20, determine the improvement of signal-to-noise ratio for the FHSS system under jamming. **(18)**

   (b) Draw and briefly explain the block diagram of a multi-user CDMA system based on DSSS. Derive the decision variable of the i^{th} receiver assuming that each user uses a single user optimum receiver. **(17)**

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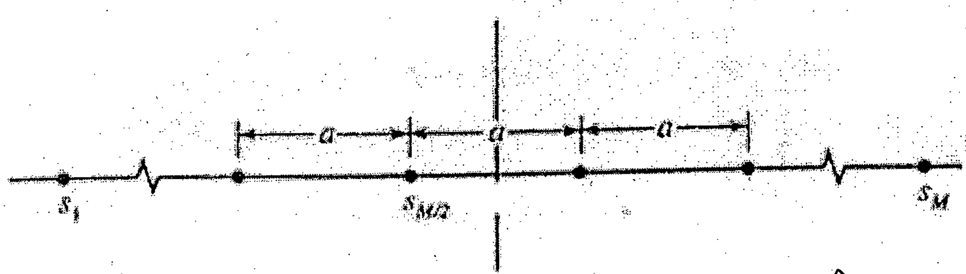

Fig. for Q. No. 3(b)

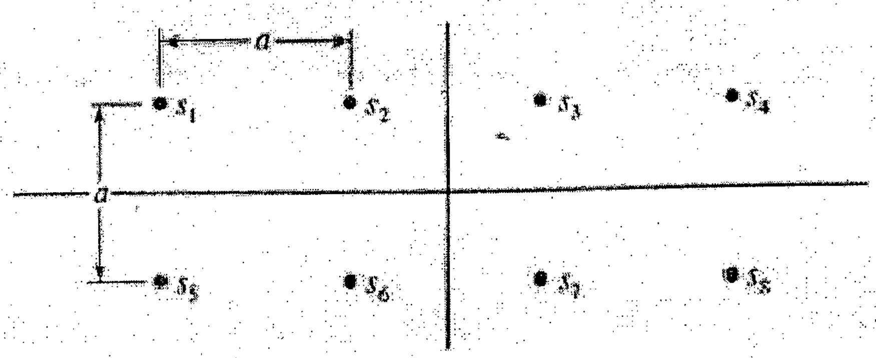

Fig. for Q. No. 4(b)

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BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

Sub: **EEE 483** (High Voltage 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**.

1. (a) With neat diagrams, describe the operating principle of three different voltage doubler circuits. For each circuit, mention when the diodes conduct and how voltage is doubled at the output terminal. Also derive the expression of Ripple Factor for any one of the three circuits. **(20)**

   (b) A Cockcroft-Walton type voltage multiplier has eight stages with capacitors, all equal to 0.05 μF. The supply transformer secondary voltage is 100 kV rms at a frequency of 1500 Hz. If the load current to be supplied is 15 mA, find (i) the percentage ripple, (ii) the regulation and (iii) the optimum number of stages for minimum regulation or voltage drop. **(15)**

2. (a) What are the main disadvantages of corona? Mention several beneficial applications of corona. With neat diagram, describe the operating principle of Van de Graff generator. **(18)**

   (b) Define corona onset level. Write down the empirical formulas for estimating corona onset level for both AC and DC corona. **(5)**

   (c) An AC conductor has a radius of 7.8 mm. Find the value of critical onset level for this conductor, when air pressure is 1.056 atm and the air temperature is 290 K. Also find the field strength needed for corona being clearly visible. **(12)**

   1 atm = 101325 Pa.

3. (a) A lightning current strikes an overhead line. The phase conductors have a cross-sectional area of 195 mm^2 and are located 8 m above the ground. The probability density function, p(i), of lightning current, i, follows triangular distribution as shown in Fig. for Q. 3(a). Plot the probability density function of overvoltage distribution, $p_o(V_k)$ from the distribution of lightning current. **(18)**

   (b) The insulation breakdown probability of the given line is represented by the linear cumulative distribution function, $P_b(V_k)$, as shown in Fig. for Q. 3(b). Here, the Statistical Withstand Voltage is 2.3 MV and no flashover occurs below 2 MV. Determine the risk of failure (R) when a lightning current strikes the overhead line. **(17)**

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

*Useful formula: Line surge impedance, $Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{\frac{\mu_0}{2\pi}\ln\left(\frac{2H}{r}\right)}{\frac{2\pi\varepsilon_0}{\ln\left(\frac{2H}{r}\right)}}}$

Where, H = Height of the line above the ground; r = phase conductor radius

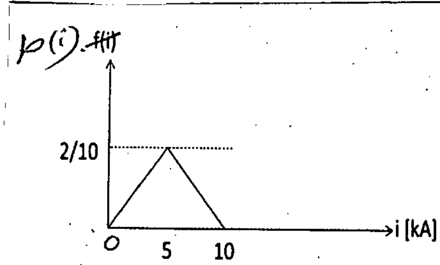

Fig. for Q. 3(a)

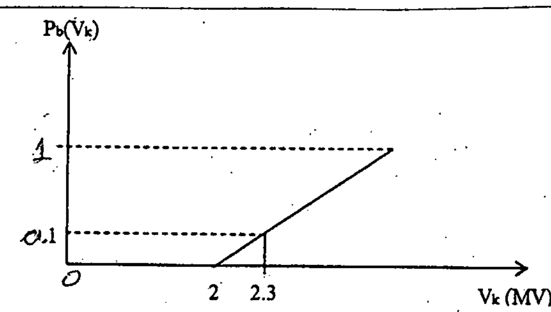

Fig. for Q. 3(b)

4. (a) What are the principal theories that have been proposed for the breakdown of insulating liquids? Explain the suspended particle theory. **(17)**

(b) Define Townsend's first and second ionization coefficients. Derive the criterion for the breakdown of a gas under electrical stress in terms of the two coefficients, as postulated by Townsend. **(18)**

SECTION – B

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

5. (a) A solid dielectric specimen of dielectric constant 4.0 shown in the Fig. for Q. 5(a) has an internal void of thickness 1.2 mm. The specimen is 1 cm thick and is subjected to a voltage of 95 kV (rms). If the void is filled with air and the breakdown strength of air can be taken as 30 kV (peak)/cm, find the voltage at which internal discharge can occur. **(15)**

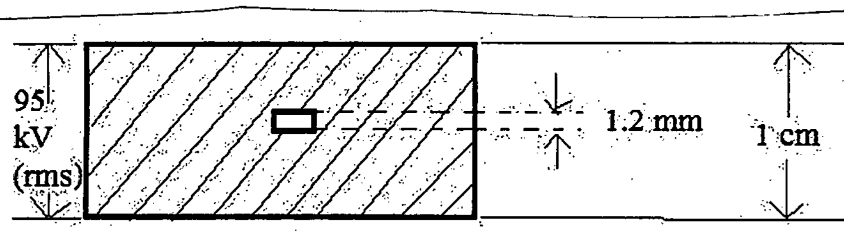

Fig. for Q. 5(a)

(b) For the solid dielectric specimen mentioned in Q. 5(a), which breakdown mechanism is most likely to occur in the presence of the air-filled void? Draw the equivalent circuit diagram of the specimen and derive the expression for the voltage across the dielectric which will initiate discharge in the cavity. **(10)**

(c) Explain electromechanical breakdown mechanism. **(10)**

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6. A circuit diagram for the single-stage impulse generator is shown in Fig. for Q. 6. Starting from the first principle, derive and plot the expression for V (t). Also find the values for R_1 and R_2 in terms of C_1, C_2, α_1 and α_2. The symbols have their usual meanings. **(35)**

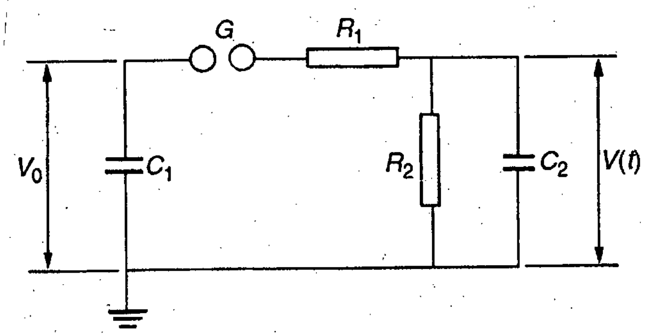

Fig. for Q. 6

7. (a) What are different types of overvoltages? For ultra-high voltages, which type of overvoltages become the predominating factor in the insulation design and why? **(5)**

   (b) Explain the lightning discharge mechanism. With neat diagram, show the developmental stages of the lightning stroke and the corresponding current surge. **(20)**

   (c) Plot the voltage distribution along the ground due to lightning strike to a building. Suppose that a person is near the edge of the building struck by lightning. In which direction should he move to remain safe against the high potential gradients over the ground surface? Justify your answer on the basis of the voltage distribution you plotted. **(10)**

8. (a) With neat diagram, explain how an electrostatic voltmeter can be used to measure DC and AC rms voltages. **(18)**

   (b) With neat diagrams, describe a method for measuring AC peak voltage. **(17)**

L-4/T-2/EEE **Date : 17/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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**.

Symbols and abbreviations have their usual meanings.

1. (a) Considering the two-ray model, show that the power received by a mobile station at a distance d from a BTS can be expressed as: **(12)**

$$P_R(d) = \left(\frac{4P_T G_T G_R}{\left(\frac{4\pi d}{\lambda}\right)^2} \right) \times sin^2\left[\frac{2\pi h_t h_r}{\lambda d}\right]$$

State the assumptions made.

(b) A base station is operating at a carrier frequency of 900 MHz with an antenna gain of 20 dB. The height of the BS antenna is 30m from ground. A mobile station (MS) is located at a distance of 300 m from the BS and has an antenna of gain 10dB at a height of 3 m from the ground. The receiver sensitivity of the MS is -90 dBm. Considering two-ray propagation model, determine the path-loss in dB and the minimum transmitter power of the BS. **(12)**

(c) Discuss the various statistical models for fading that occurs in different channel conditions of a wireless communication system. **(11)**

2. (a) What is spread-spectrum technique? Discuss the principle of spread spectrum CDMA with appropriate diagrams. **(10)**

(b) Draw the block diagram of a direct sequence (DS) - CDMA system with transmitter and receiver blocks. Derive the expression of signal to multi-access interference (MAI) plus noise ratio for a given number of simultaneous user. State the conditions for zero MAI. **(15)**

(c) Draw and explain the following performance curves for a DS-CDMA wireless system: **(10)**

(i) Bit error rate versus number of simultaneous user for a given code length.

(ii) Allowable number of simultaneous user versus processing gain at a given BER.

3. (a) What is meant by orthogonality of two-carriers? Estimate the amount of bandwidth that can be saved by using OFDM instead of FDM for a given system bandwidth. (12)

Contd P/2

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Contd ... Q. No. 3

(b) With necessary block diagram, discuss the steps that are followed to generate an OFDM symbol. Explain the purpose of cyclic prefix (CP). **(12)**

(c) Discuss the principles of operation of various Multi-carrier CDMA systems. State their merits over single-carrier (SC)-CDMA. **(11)**

4. (a) Why diversity in transmission is very much important for a wireless communication system? Discuss briefly the various transmit/receive diversity techniques that may be employed in a wireless system. **(12)**

(b) Draw the reference architecture of a GSM system and discuss the function of each block. **(10)**

(c) Write short notes on (any one): **(13)**

(i) Frequency Hopping (FH) - CDMA.

(ii) Signal Processing in a GSM MS.

(iii) 3G/4G Wireless technology.

SECTION – B

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

Answer in brief and to the point.

5. (a) Derive an expression for the impulse response of a wireless mobile channel and explain the limitations imposed by the channel on the performance of a link. **(10)**

(b) Define the following transfer functions of a wireless channel: **(15)**

(i) Time-variant transfer function,

(ii) Doppler transfer function,

(iii) Delay-Doppler transfer function.

Discuss their relationships with the impulse response of a wireless channel.

(c) Define coherence bandwidth, Doppler spread and Doppler bandwidth of a channel and explain their significance in relation to channel performance. **(10)**

6. (a) What is multipath fading? Distinguish among frequency selective fading, flat fading and time selective fading. **(10)**

(b) Derive the expression of the bit error rate (BER) of a BPSK wireless link with coherent receiver under the influence of Rayleigh fading. **(15)**

Explain the effect of fading on the BER performance.

(c) State the various techniques that can be adopted to overcome the effect of fading in a wireless channel. **(10)**

Contd P/3

EEE 439

7. (a) What is the purpose of frequency or code reuse in a wireless cellular mobile communication system? Explain the mechanism of frequency reuse in a cluster of cells and define the reuse factor, reuse distance and reuse ratio. **(10)**

(b) Find the expression of carrier-to-co-channel interference (CCI) ratio in a hexagonal cell structure. Discuss the techniques of overcoming the effect of CCI in a cellular communication system. **(8+5=13)**

(c) A cellular mobile system requires a minimum C/CCI of 27dB in a channel environment with path loss exponents, $\gamma = 3.5$. **(12)**

Determine the minimum required reuse factor and draw the reuse pattern with minimum two co-cells.

8. (a) What are the different types of multiple access techniques applied in various generations of cellular mobile system? Discuss them with examples. **(10)**

(b) Discuss the principles of operation of the following techniques:

(i) WB-TDMA, (ii) NB-TDMA, (iii) FDMA-FDD, (iv) FDMA-TDD. **(12)**

Comment on their relative merits and limitations.

(c) Define the spectral efficiency of a mobile cellular system with FDMA-FDD. Explain the parameters involved. **(5+8=13)**

An FDMA-FDD mobile cellular system has a one-way system bandwidth of 25MHz with guard band of 100 KHz at each end of the spectrum. The coverage of a 7-cell cluster is 24 km^2. The number of control channel per cluster is 42. Determine the number of available traffic channel per cell and spectral efficiency of the system.

L-4/T-1I/EEE **Date : 17/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-1 B. Sc. Engineering Examinations 2016-2017

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) Draw E-K diagram of GaP and GaAs semiconductors and explain possible optical transition mechanisms. With necessary diagrams, show and explain composition dependence of bandgap and Energy-momentum diagram for $GaAs_{1-x}P_x$ system. **(20)**

   (b) What is Brewster law? Explain a method to obtain plane polarized light from unpolarized light. A light beam traveling in air is incident on a glass plate of refractive index of 1.5. Calculate corresponding Brewster angle. What would be the Brewser angle if the light direction is reversed? **(15)**

2. (a) Describe Malus's law and explain its significance. Find the angle between the transmission axes of two plarizers for the transmitted light intensity through both polarizers to be 75% and 50%. **(20)**

   (b) What is Faraday effect? With suitable diagrams, discuss the operation of Pockels cell intensity modulator. What would be the thickness of a quarter-wave quartz plate retarder for a wavelength $\lambda = 600$nm? Given: $n_e = 1.5533$, $n_0 = 1.5442$. **(15)**

3. (a) Why guard ring structure is used in APDs? Draw energy band diagram of staircase superlattice APD with and without applied bias and explain its operation. Discuss merits and demerits of such structured APDs. (20)

   (b) Derive expression for NEP of photodetectors. Consider an ideal photodiode with $\eta = 1$ and no dark current. Calculate the minimum optical power for an SNR = 1 for the ideal photodetector operating at 1500 nm with a band width of 1 GHz. Also calculate corresponding photocurrent. **(15)**

4. (a) With appropriate equations, describe the effect of temperature on open circuit voltage of a solar cell. Explain various loss mechanisms that typically limit the PV cell efficiency. **(20)**

Contd P/2

EEE 459

Contd ... Q. No. 4

(b) A Si solar cell under an illumination of AM1 has a short circuit current of 24 mA and open circuit voltage of 0.5V at 60°C. What are the short circuit current and open circuit voltage when the illumination of the cell is 600 W/m^2 at 20°C? Given: n = 1 and total incident power for AM2 is 691 W/m^2. **(15)**

SECTION – B

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

5. (a) Draw the schematic diagram of a typical double-heterostructure (DH) light emitting diode (LED). With necessary band diagrams, describe the operation of the DH LED. How the drawbacks of homojunction LED are overcome in DH LED? **(15)**

(b) The ternary alloy on $In_{1-x}Ga_xAs_yP_{1-y}$ grown on InP crystal substrate is a suitable semiconductor material for infrared wavelength LED. The device requires that the InGaAsP layer is lattice matched to InP crystal substrate to avoid crystal defects in the InGaAsP layer. This in turn requires that $y \approx 2.2x$. The bandgap E_g for this ternary alloy in eV is given by the empirical relationship, **(20)**

$$E_g \approx 1.35 - 0.72y + 0.12y^2; \; 0 \le x \le 0.47$$

(i) Calculate the composition of InGaAsP ternary alloy for peak emission at a wavelength of 1.3 μm. (ii) What is the linewidth, i.e. full width half maximum, in the output spectrum at a wavelength of 1.3 μm? Assume that the width of the relative light intensity vs. photon energy spectrum of this LED is around ~ $3k_BT$.

6. (a) Draw the schematic of DH surface emitting LED (SLED) structure. Describe two typical structures used to couple light from SLEDs into optical fiber with necessary diagrams. Discuss the optical properties of typical materials used in confining layers of these LEDs. **(20)**

(b) Explain the effect of nitrogen incorporation in $GaAs_{1-x}P_x$ LED in terms of emission wavelength and quantum efficiency. Propose an appropriate substrate material that can be used for GaAsP LED designed to emit orange light. Validate the proposed material. **(15)**

7. (a) Write down the power and phase conditions for laser oscillations. Derive the expressions for threshold gain coefficient and threshold population inversion for an optical cavity resonator laser. **(17)**

(b) Draw schematic of a gain guided laser diode? What are the advantages of these lasers? How the efficiency of such lasers can be improved? **(10)**

Contd P/3

EEE 459

Contd ... Q. No. 7

(c) Consider a distributed feedback (DFB) laser has corrugation period Λ of 0.3 μm and a grating length of 500 μm. The effective refractive index of the medium is 3. Assuming a first order grating, calculate the Bragg wavelength, the mode wavelengths and their separation. **(8)**

8. (a) Define transparency current and threshold current for a laser diode. **(5)**

(b) How are the carrier and optical confinement of DH laser much better than homojunction or single heterojunction laser? Justify with necessary diagrams. **(12)**

(c) What are the advantages of quantum well (QW) laser over bulk semiconductor lasers? **(5)**

(d) Calculate the change in the emission wavelength of GaAs QW laser with respect to bulk GaAs laser. Given that in GaAs effective mass of a conduction band electron is $0.07m_e$ and effective mass of a valance band hole is $0.5m_e$, where m_e is the electron mass in vacuum. Quantum well thickness is 10 nm and energy bandgap of bulk GaAs is 1.42 eV. Consider the first electron energy level and first hole energy level of the QW. **(13)**

L-4/T-2/EEE **Date: 23/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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**.

Symbols have their usual meanings unless stated otherwise.

1. (a) For a one dimensional diatomic lattice, derive the dispersion relation and find the relationship between the amplitude of vibrations of the two atoms in the acoustic and optical branches for long wavelength limits. **(17)**
Plot the shapes of the optical and acoustic branches in the dispersion relation for two different ratios of masses: $M/m = 5$ and 1.
(b) A periodic lattice of transversely oscillating masses coupled together by nearest neighbour Hooke's law force. Derive the equation of motion for transverse waves. **(10)**
(c) In a certain monoatomic lattice of spacing $a = 3 \times 10^{-10}$ m and mass m = 40 amu, the longitudinal group velocity is 2700 m/s. The cutoff frequency for longitudinal oscillations is 2.5×10^{13} rad/s. What is the phase velocity of these waves? What is the quasi-elasticforce constant and the long wavelength longitudinal sound velocity? (1 amu = 1.665×10^{-27} kg) **(8)**

2. (a) Show that 'a linear monatomic lattice works as lowpass filter.' **(10)**
(b) If a signal has a frequency 1% greater than the cut-off frequency of the monoatomic crystal with interatomic space of 3Å, determine the distance at which the signal is attenuated in amplitude by a factor of 1/e. **(7)**
(c) Find the expression for the Einstein specific heat in the limit of very low temperatures and very high temperatures. **(18)**

3. (a) Derive the general expression of probability amplitude, $a_f(t)$ within the Fermi's golden rule for scattering from an initial state 'i' to a final state 'f'. **(17)**
(b) Derive the expression of the scattering rate induced by a perturbation potential $\hat{V}(r)e^{-iw_0 t}$ in a bulk semiconductor. If this perturbation is caused by a photon, does it correspond to photon emission or photon absorption? **(13)**
(c) What is short range potential? Show that for such a potential, $\theta = \frac{q}{k}$. **(5)**

Contd P/2

4. (a) Derive the expressions of the electron-photon absorption and emission scattering rates in a system. **(20)**

(b) Briefly explain "Born Approximation". **(7)**

(c) Derive the following relationship between phase and group velocities: **(8)**

$$\frac{dvg}{dk} = \frac{1}{k}\left(- \frac{vp}{vg} \right)$$

List of Equations

The different terms used in these equations have their relevant meanings.

$$a_f(t) = \frac{1}{i\hbar}\int_0^t V_{fi}(t')\, e^{iE_{fi}t'/\hbar}\, dt'$$

$$\hat{H} = \frac{1}{2m_0}\left(\hat{p} - e\bar{A}\right)^2 + e\phi + V(r)$$

$$W = \frac{2\pi}{\hbar}\sum_f |\langle f|H'|i\rangle|^2\, \delta\left(E_f - E_i \mp \hbar\omega\right)$$

$$A_0 = \sqrt{\frac{\hbar}{2\omega\epsilon V}}\left(b^\dagger + b\right)$$

SECTION – B

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

5. (a) For the quantum well shown in the Fig. for Q. 5(a), derive a relation which can be used to estimate bound state energies of the confined electron, where the electron effective mass in m_e. Graphically explain how the number of bound states will change in this system if the conduction band offset ΔE_c increases for constant well width W, or if the well width changes for a constant ΔE_c. **(18)**

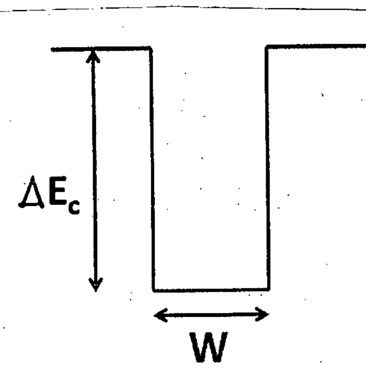

Figure for Question 5(a)

EEE 461

Contd... Q. No. 5

(b) 'Electrical conductivity arises from motion of electrons in filled bands' — do you agree with this statement? Explain in terms of the energy band diagrams of metals, insulators and semiconductors. **(10)**

(c) Define longitudinal and transverse effective mass in a solid. For your definition, write down the expression of energy-momentum relation within the parabolic approximation. **(7)**

6. (a) Apply tight-binding model to estimate the energy states in a diatomic molecule. Based on your derivation, define bonding and anti-bonding molecular orbitals. **(18)**

(b) Using wave-particle duality, derive the expression of electron effective mass in a solid. What is the physical significance of negative effective mass? **(10)**

(c) Define conductivity in a n-doped semiconductor material. Why electrical conductivity in semiconductors is more strongly dependent on temperature than in metals. **(7)**

7. (a) Consider a solid medium where a particle of mass m^* is free to move along the x- and y- directions, however its movement is constrained along the z-direction. Derive the appropriate expression of density of states in this system for this particle. **(16)**

(b) Derive Einstein's relation in a uniformly doped semiconductor under a constant applied field **E(x)**. Is this relation valid for both degenerate and non-degenerate semiconductors? Why? **(11)**

(c) What are the underlying assumptions of the Nearly Free Electron model? In accordance with this model, draw the extended zone representation of E-k diagram and explain the discontinuity observed at the zone boundary. **(8)**

8. (a) Using T-matrix formalism, derive the expression of transmission coefficient as a function of energy for a resonant tunneling structure. Based on your derivation, draw the transmission coefficients for resonant tunneling in both single and double barriers. **(20)**

(b) Write down Boltzmann transport equation and define different terms used in it. Using relaxation time approximation, obtain the first order solution of this equation and write down the expression of current density using it. **(15)**

L-4/T-2/EEE **Date: 23/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

Symbols and abbreviation have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Answer in brief and to the point.

1. (a) Mention the relative merits of central battery operation of a telephone compared to the local battery operation. **(9)**

(b) Describe, with an appropriate circuit diagram, how the central battery is shared between many subscribers in a telephone exchange. **(8+4=12)**

Mention the basic reason for connecting the positive terminal of the central battery to the ground.

(c) With a neat sketch, describe the components of a 4-digit step-by-step (stronger) automatic telephone exchange. Also, show the appropriate trunking diagram when a subscriber dials his/her friend at 4798, under this telephone exchange. **(8+6=14)**

2. (a) Name the basic components of a telephone hand-set. **(5+8=13)**

Describe the operation of an ASTIC during speech transmission and reception in a telephone hand-set.

(b) Describe the purposes of two-wire and four-wire systems in telecommunication. What role does a hybrid play in this connection? **(6+3=9)**

(c) Why do we use multiple-stage switches instead of single-stage switches in a telephone exchange? **(3+10=13)**

Write down the equation for the total number of crosspoints (N_x) required by a three-stage switch and show that for a large non-blocking three-stage switch, the optimum value of n is $\sqrt{\frac{N}{2}}$. Using this value of n, calculate $N_x|_{\min}$.

3. (a) Explain, why each connection in a digital time-division switching requires two transfers of information: each involving translations in both time and space. **(7)**

(b) Suppose that a two-dimensional switching matrix consists of a time switch (N-inlet TSM) followed by a space switch (N×N) with a control store. **(13)**

Determine the implementation complexity of the TS switch, where the number of TDM input lines N = 80. Assume each input line has 24 channels.

(c) With a neat diagram, describe the operation of a TST switch. Comment on the use of STS and TST switching structures in practical applications. **(10+5=15)**

Contd P/2

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4. (a) Define traffic intensity and explain the meaning of "1 Erlang of traffic in a trunk or server". **(5+5=10)**

A group of 20 trunks (servers) carry a traffic of 10 E. If the average duration of a call is 3 minutes, calculate the number of calls put through by a single server and the group as a whole in a one-hour period.

(b) Define Grades of Service (GoS). During a busy hour, 1400 calls were offered to a group of trunks and 14 calls were lost. The average call duration is 3 minutes. Find (i)Traffic offered, (ii) Traffic carried, (iii) GoS and (iv) the total duration of period of congestion. **(2+8=10)**

(c) Cite examples for a random process and random variables in tele-traffic modeling. **(2+5+8=15)**

Discuss, in brief, the Poisson arrival distribution and holding-time distribution.

Assume that a trunk group has enough channels to carry all of the traffic offered to it by Poisson process with an arrival rate of one call per minute. The average holding time is 2 min. (i) What percentage of the total traffic is carried by the first five circuits? and How much traffic is carried by all the remaining circuits?

SECTION – B

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

5. (a) Describe briefly the principle of packet switching technique. How it is different from circuit switching? **(7+4=11)**

(b) Define Internet Telephony (IPT). Name four types of IPT usage scenario. **(3+9=12)**

With neat sketches, draw the types of possible network configurations for VoIP and label them.

(c) Name the architectural elements of VoIP as per H.323 standard and explain their functions. State the basic difference of VoIP and IPT. **(9+3=12)**

6. (a)What is ISDN and what are the objectives of developing ISDN? State the merits of ISDN. **(10+3=13)**

Distinguish between N-ISDN and B-ISDN.

(b) What is ATM and what is the popular transmission medium for ATM? Mention the main features of ATM briefly. **(9)**

(c) With neat sketch, discuss the principle of operation of an ATM switch. What are the ATM cell formats and ATM rates? **(13)**

Contd P/3

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7. (a) What are the network components of a GSM cellular communication system? State their functions briefly. **(6+6=12)**

Define a cluster and a co-channel cell. With neat sketch describe the method of locating a co-cell in a neighboring cluster for a 7-cell reuse pattern.

(b) Define the co-channel Interference reduction factor q and C/I ratio and find their relationship for a hexagonal cell structure. Determine the minimum required C/I for a cellular system with 7-cell cluster with path-loss exponent $\gamma = 3.0$.

(c) What are the various states that an MS can be in and mention the possible activities in each state? **(5+7=12)**

With a neat sketch, describe the basic call-set up process from a PSTN subscriber to an MS at a different location.

8. (a) What are the different types of satellites and their orbits? What are the components of a communications satellite? Discuss their functions briefly. **(10+2=12)**

Mention three different bands for communications satellites with specific applications.

(b) With necessary block diagrams, derive the link equations for a satellite communication link. State the procedures of designing a satellite link. **(10)**

(c) What is satellite link budget and what are its purposes? **(3+10=13)**

The system specification of a k_n-band Geo-satellite with bent-pipe transponders to broadcast digital TV signals from an earth station to many receiving stations is given in Table for Q. 8(c).

(i) Determine the uplink transmitter power required to achieve (C/N) = 30 dB in clear air atmosphere.

(ii) How the transmitter power can be reduced keeping the (C/N) same.

Assume: K = –228.6 dBW/K-Hz.

Table for Q. No. 8(c): System and Satellite Specifications

Heading	Name of Parameter	Value(s)
Ku-band satellite parameters	Geostationary at 73° W longitude, 28-Ku band transponders Total RF output power Antenna gain, on axis (Transmit and receive) Receive system noise temperature Transponder saturated output power: Ku band Transponder bandwidth: Ku Band	 2.24 kW 31 dB 500° K 80 W 54 MHz
Signal	Compressed digital video signals with transmitted symbol rate of **43.2 Msps** Minimum permitted overall $(C/N)_O$ in receiver	 9.5 dB
Transmitting Ku-band earth station	Antenna diameter Aperture efficiency Uplink frequency Required C/N in Ku-band transponder Transponder HPA output backoff Miscellaneous uplink losses Location: – 2 dB contour of satellite receiving antenna	5 m 68% 14.15 GHz 30 dB 1 dB 0.3 dB
Receiving Ku-band earth station	Downlink frequency Receiver IF noise bandwidth Antenna noise temperature LNA noise temperature Required overall $(C/N)_O$ in clear air Miscellaneous downlink losses Location: – 3 dB contour of satellite transmitting antenna	11.45 GHz 43.2 MHz 30° K 110° K 17 dB 0.2 dB
Ku-band clear air attenuation	Uplink: 14.15GHz Downlink: 11.45GHz	0.7 dB 0.5 dB
Rain attenuation	Uplink: 0.01% of year Downlink: 0.01% of year	6.0 dB 5.0 dB

L-4/T-2/EEE **Date: 23/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

All the abbreviations have their usual significance

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Why does frequency decline if load increases in a power system? **(5)**

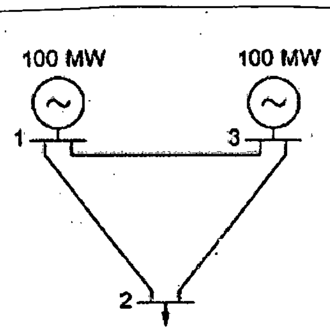
(b) Explain when free governor mode operation, AGC and auto load shed are necessary. **(12)**

(c) What needs to be done to implement electricity market and smart grid concept in Bangladesh Power System? **(8)**

(d) If the following voltage samples (on PT secondary side) acquired from a substation bus are processed by a RTU what will be the RMS voltage magnitude? If the same samples are processed by a PMU having time synchronization with GPS what will be the RMS voltage phasor? **(10)**

k	Sample magnitude
1	0.5 V
2	1.0 V
3	0.4 V

2. For the following system calculate the base case phase angles and line flows. Bus 3 generator is the slack. Then calculate the RI (Ranking Index) respectively for outage of generator at bus 1 and line 2-3. Show the calculations of all the required matrices. Each generator has a maximum capacity of 200 MW. Use DC model for computations. **(35)**



Line	Reactance pu ($S_{Base} = 100$ MVA)	P_f^{max} MW
1-2	0.1	200
2-3	0.1	200
1-3	0.1	100

Fig. and Table for Q. 2(b)

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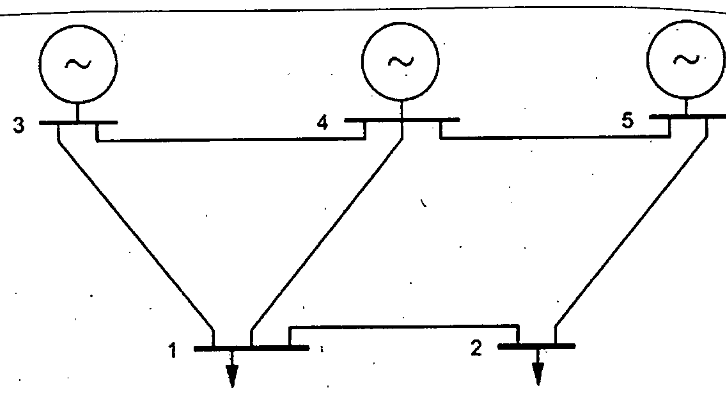
3. (a) Starting with the generalized framework for OPF describe step wise the procedure to solve it using gradient technique? Also mention how are the inequality constraints handled? **(15)**

(b) For the following system if line 1-3 trips some of the lines will be overloaded. Show the OPF formulation using DC model and considering preventive actions (generation rescheduling) as well as corrective actions (generation rescheduling and load shedding). Give zero penalties to corrective generation rescheduling. For load shed and preventive generation rescheduling at the concerned buses assume reasonable weighting factors. Bus 5 generator is the slack. **(15)**



Node	P_L MW	Q_L Mvar	P_G MW	P_G^{max} MW	P_G^{min} MW	V^{sp} pu	Q_G^{max} Mvar	Q_G^{min} Mvar
1	1500	750	—	—	—	—	—	—
2	500	250	—	—	—	—	—	—
3	0	0	1000	1500	250	1.05	750	−750
4	0	0	750	1500	250	1.05	750	−750
5	0	0	309	1000	250	1.05	500	−500
Voltages				$0.95 \le V \le 1.05$				

Line i, j	Resistance	Reactance	Shunt Susceptance	P_f^{max} MW
	pu (P_{base} = 100 MVA)			
L1 1-2	0.002	0.01	0.002	1000
L2 1-3	0.004	0.02	0.004	1000
L3 1-4	0.002	0.01	0.002	1000
L4 2-5	0.004	0.02	0.004	1000
L5 3-4	0.004	0.02	0.004	1000
L6 4-5	0.004	0.02	0.004	1000

Fig. and Tables for Q. 3(b)

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

The bus susceptance matrix before outage of line 1-3 is

$$\begin{bmatrix} 250 & -100 & -50 & -100 \\ -100 & 150 & 0 & 0 \\ -50 & 0 & 100 & -50 \\ -100 & 0 & -50 & 200 \end{bmatrix}$$

The bus susceptance matrix after outage of line 1-3 is

$$\begin{bmatrix} 200 & -100 & 0 & -100 \\ -100 & 150 & 0 & 0 \\ 0 & 0 & 50 & -50 \\ -100 & 0 & -50 & 200 \end{bmatrix}$$

(c) How can you ensure that the OPF solution will comprise both preventive and corrective generation reschedules? **(5)**

4. (a) Show the single-period and multi-period auction formulations for determining MCPs by an ISO in electricity market. Show the meanings of main notations used in the formulations. **(15)**

(b) In a certain hour ISO receives on-line the following offers and bids respectively from 3 GenCos. and 2 DisCos. Each offer has 3 blocks and each bid has 4 blocks. Calculate the MCP and social welfare after determining the offers and bids acceptable to the ISO. Use a plain graph paper for the determination process and attach this with your script. **(20)**

GenCo 1: (5,1), (12,2), (13,3)
GenCo 2: (8,4), (8,5), (9,6)
GenCo 3: (10,7), (10,8), (5,9)

DisCo 1: (8,20), (5,15), (5,8), (3,4)
DisCo 2: (7,18), (4,16), (4,14), (3,3)

The first figure in each block (bracket) shows the MW and the second figure shows the price in \$/MW/hr.

SECTION – B

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

5. (a) With a functional diagram, explain the operation of a PMU. **(10)**

(b) What is security control? What are the basic functions of security control? With a block diagram, explain the status of a power system from security point of view. **(12)**

(c) Two areas of a power system are connected via a tie line with the following characteristics. **(13)**

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
f = 50 Hz	f = 50 Hz

A load increase of 100 MW occurs in Area-2. What is the change in tie-line flow?

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6. (a) Why is state estimation necessary? What is observability? Write two main conditions for a system being observable. **(12)**

(b) For the circuit shown below, the meter readings are z_1 = 9.01 A, z_2 = 3.02 A, z_3 = 6.98 V and z_4 = 5.01 V. Assume that ammeters are more accurate than voltmeters, and measurement weights are w_1 = 100, w_2 = 100, w_3 = 50 and w_4 = 50. Determine the weighted least-squares estimates of voltage sources V_1 and V_2. Given that **(23)**

$$H = \begin{bmatrix} 0.625 & -0.125 \\ -0.125 & 0.625 \\ 0.375 & 0.125 \\ 0.125 & 0.375 \end{bmatrix}$$

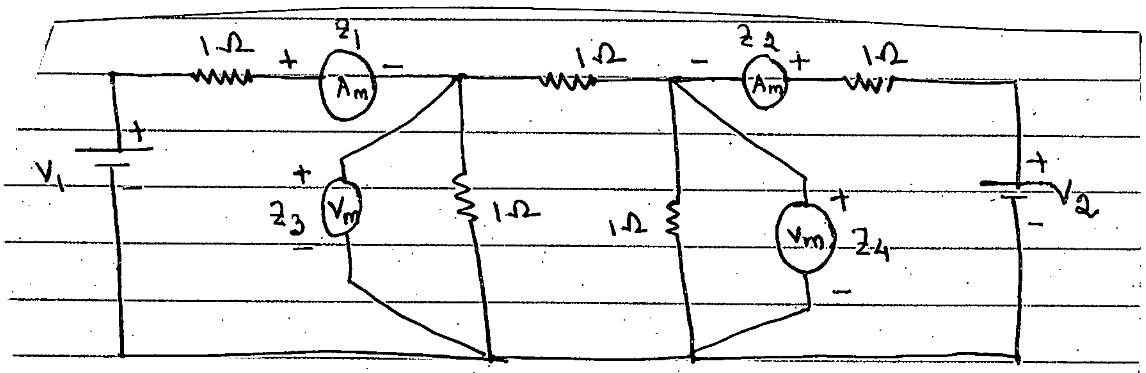

Fig. for Q.6(b)

7. (a) What is the difference between unit commitment and economic dispatch? **(5)**

(b) Explain the backward dynamic programming approach to solve unit commitment problem. **(15)**

(c) A power system has four generators with relevant data shown in Table 7.1. Determine the power supplied by the generators of the each combination shown in Table 7.2. Also determine the corresponding production cost in economically loading the units. Assume the system load is 1100 MW. **(15)**

Table 7.1: Technical and economic parameters

Generating Unit	Min. (MW)	Max (MW)	a_i $/(MW)^{2}h	b_i $/(MW)h	c_i $/h
1	100	625	0.008	8.0	500
2	100	625	0.0096	6.4	400
3	75	600	0.0100	7.9	600
4	75	600	0.011	7.5	400

Table 7.2: Possible Unit Combination

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

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8. (a) What is the role of supplementary control in AGC? Draw the block diagram of supplementary control added to generating unit. **(2+5)**

(b) What is an EMS? Draw the basic architecture of an EMS. **(5)**

(c) What is SCADA? Draw the basic structure of a SCADA system. **(5)**

(d) A power system has three areas with the following data. **(18)**

Area	R (Pu)	Rated capacity (MW)	Load (MW)	B (MW/ 0.1 Hz)
A	0.02	16,000	12,800	–1200
B	0.0125	12,000	9,600	–1500
C	0.01	6,400	5,120	–950

For reason of economy, area C is importing 500MW of its load requirements from area B, and 100 MW of this interchange passes over the tie lines of area A, which as a zero scheduled interchange of its own. Determine ACE of each area when 400 MW generation is forced out of service at area B.

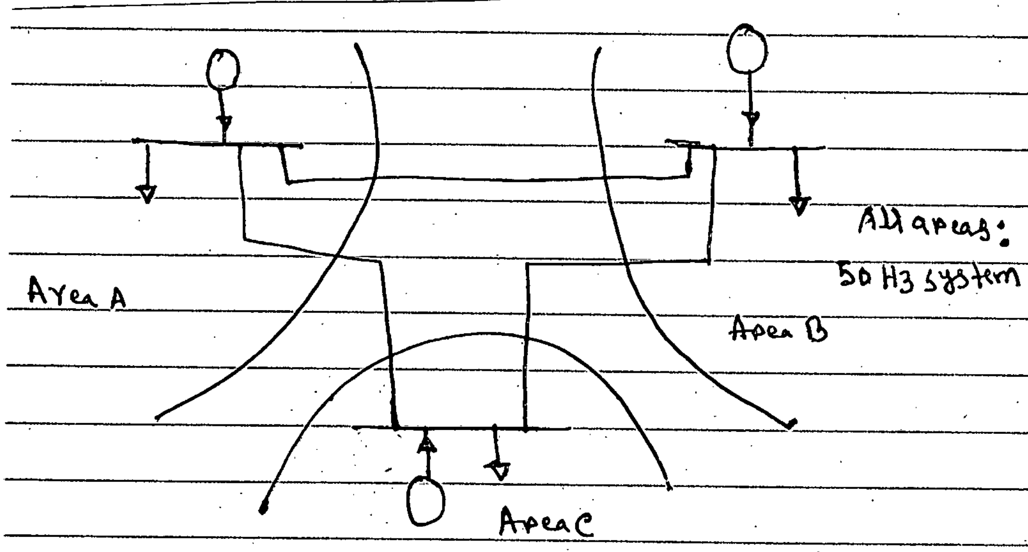

Fig. for Q.8(d)

L-4/T-2/EEE **Date: 29/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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 figures in the margin indicate full marks.

1. (a) Define bioelectric transducer and write its characteristic features. With neat diagrams, describe the operation of resistive, inductive and capacitive transducers and their application in bioelectric measurement. **(15)**

   (b) Describe how bioelectric electrodes convert ionic voltage into electrical potential. Classify bioelectric electrodes. Describe the construction and operation of a typical Ag-AgCl electrode. Explain how the shape, size, material and energy requirement of an electrode affect the signal measurement. **(15)**

   (c) Define half-cell potential and over-potential of body surface. **(5)**

2. (a) Name the chemical parameters of blood normally tested in general diagnosis. Describe the operation of spectrophotometer and aperture impedance cell counter. **(15)**

   (b) Define bioelectric potential and describe the formation of resting and action potentials. Write the significance of each potential level in a typical cycle of it. **(15)**

   (c) Define biometrics and write its main design factors. **(5)**

3. (a) Describe the basic principle of medical ultrasonography. Write about the velocity of ultrasound in different organs of human body. Describe different scanning modes of ultrasound-based imaging. **(15)**

   (b) Define scintigraphy and write the uses of different types of scintigraphy. Briefly describe CT, SPECT and PET. **(15)**

   (c) Describe different effects of X-ray. **(5)**

4. (a) Describe the components of a biological neuron. Write the characteristics of different waves in normal EEG and discuss their changes with specific abnormality. **(15)**

   (b) Define different components of ERG. Name the factors that affect ERG. Describe normal ERG responses under scotopic and photopic conditions. **(15)**

   (c) Write a short note on EMG. **(5)**

Contd P/2

SECTION – B

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

Symbols and abbreviations have their usual meanings.

The questions are of equal value.

5. (a) Briefly describe different types of artificial pacemakers considering their modes of operation.

   (b) With a neat diagram, discuss the operation of a flame photometer.

6. (a) Enumerate the various methods of measuring blood flow. Briefly describe the working principle of blood flow measurement by electromagnetic induction.

   (b) What is palpatatory method for obtaining blood pressure? Describe in brief the workings of an extravascular sensor-based blood pressure measurement method.

7. (a) What is heart murmur? Explain the diagnosis of different types of stenosis and regurgitation based on heart sounds.

   (b) A patient has a cardiac output of 4 litres/min and heart rate of 90 bpm. The total volume of blood in circulation is 5 litres and the aorta has a circular cross-section with diameter 32 mm. Calculate (i) the stroke volume, (ii) the mean circulation time, and (iii) the mean blood velocity in the aorta. Why does a blood flow meter give the average velocity of blood instead of its actual value?

8. (a) Briefly discuss the interferences from power line and different sources of electromagnetic signals in ECG recordings. Suggest ways to suppress these interferences.

   (b) Write short notes on the following:

   (i) Resting and Recovery heart rates,

   (ii) Serological and Bacteriological tests of blood.

L-4/T-2/EEE **Date: 29/09/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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) Show the generalized functional elements of measurement systems in a block diagram and explain them briefly. **(10)**

(b) Describe 'Accuracy' and 'Precision' with proper sketches, in relation to measurement instruments. **(10)**

(c) Design an Ayrton Shunt based multi-range ammeter with current ranges of 10 mA, 100 mA and 1 A with a basic PMMC meter movement having a full-scale deflection current of 1 mA and an internal resistance of 100 Ω. **(15)**

2. (a) Describe, with necessary sketches and mathematical derivations, how a PMMC meter movement can be used to measure ac voltage and current. **(15)**

(b) A typical ac voltmeter used in a commercial multimeter is shown in Fig. for Q. No. 2(b). The basic PMMC meter movement has a internal resistance of 100 Ω and require 1 mA for full-scale deflection. The shunting resistor, R_{sh}, has a value of 50 Ω. Assuming ideal diode characteristics, calculate:

(i) The series resistance required for full-scale deflection when a triangular waveform with a peak value of 20 V is applied to the meter terminals. **(15)**

(ii) The sensitivity of the voltmeter. **(5)**

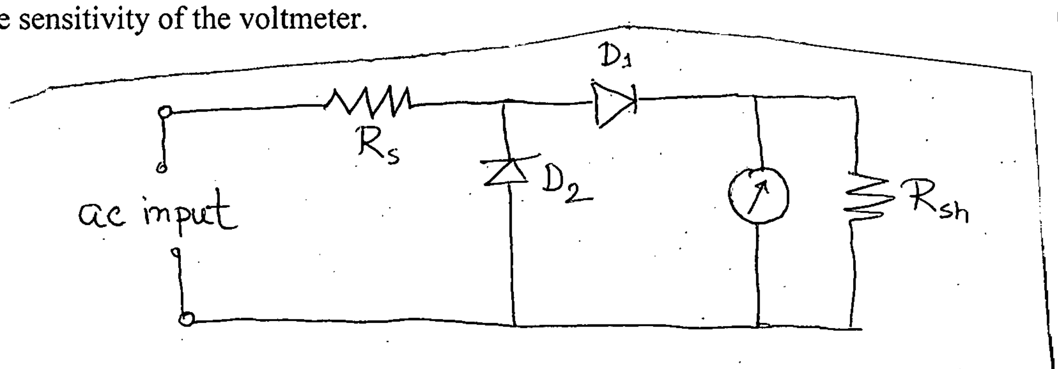

Fig. for Q. no. 2(b)

3. (a) With neat sketches, describe the construction and working principle of single-phase induction type energy meters. **(5+5)**

(b) What are the functions of 'Instrument Transformers'? Describe the working principle of a 'Clamp-on Ammeter'. **(5+5)**

(c) Design a switching and amplification gain selection circuit for an electronic analog dc voltmeter using FET switches and an OP-AMP. The input ranges of the voltmeter shall be 10 mV, 100 mV, 1 V, and 10 V. The maximum voltage at the output of this circuit should be 1 V for any range. The input resistance of the voltmeter should be 10 MΩ for the ranges greater than 1V. **(15)**

Contd P/2

EEE 427

4. (a) Write down the advantages of electrical methods of transduction. **(7)**

(b) With a neat sketch, explain the operation of a displacement transducer that works on the principle of production of eddy current. **(7)**

(c) Why differential output is advantageous compared to single output, in relation to transducer configurations? **(6)**

(d) Draw the configuration of a variable distance capacitive linear displacement transducer that provides linear response. Derive the expression of *sensitivity* for this configuration. **(15)**

SECTION – B

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

5. (a) Briefly explain the working principle of PMT and justify the statement that, "PMT is apparently a single photon detector". **(15)**

(b) Briefly explain the working principle of turbine flowmeters. **(10)**

(c) Why threshold comparator is generally used after a turbine flowmeter? Explain how it works. **(10)**

6. (a) Describe the "capacitive voltage divider method" for measurement of liquid levels. **(12)**

(b) Draw the circuit configuration of an instrumentation amplifier and derive the expression for total differential gain. Mention the advantages of this amplifier. **(15)**

(c) A differential amplifier has two inputs of 5 mV and 3 mV. **(8)**

(i) Design the circuit to provide an output of 300 mV; specify the resistance values used in your design. What is the amplifier gain?

(ii) If now inputs of 153 mV and 155 mV are applied, what will be the output voltage?

7. (a) Explain how noise can be coupled capacitively into a measurement system. What are the possible solutions to this type of interference? **(10)**

(b) 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 the operating equation for Kelvin Double Bridge. **(15)**

(c) Briefly explain how Flash ADC works. **(10)**

8. (a) With necessary block diagrams and signal sketches, briefly describe the steps of FDM at both remote site/airborne system and base station/ground station. **(20)**

(b) Describe frequency telemetry. What is its advantage over amplitude based telemetry? **(6)**

(c) Write short note on "Maxwell's Inductance-Capacitance Bridge". **(9)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2016-2017

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

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 do we need to use numerical methods to solve engineering problems? **(10)**

(b) Briefly discuss about truncation, rounding-off and algorithmic errors that may come into the computations of engineering problems. **(10)**

(c) Define (i) absolute error, (ii) relative error, and (iii) percentage error in result of a numerical calculation. **(6)**

(d) In the evaluation of $\left(\frac{2.13-0.356}{12.6\times 2.51}\right)^4$ assuming the maximum truncation error in each figure, estimate the limits between which the calculated value probably lies. **(9)**

2. (a) Derive the condition at which the iteration will converge to find root of a non-linear function $f(x) = 0$ by iterative method. **(8)**

(b) Derive the expression for the next approximation of a root of the non-linear equation $f(x) = 0$ at a particular iteration stage by Newton-Raphson method. **(8+9)**

Briefly describe the limitations of this method to find the root.

(c) Briefly describe the interval bisection method to find root of a non-linear equation. Also provide algorithm while using this method to find the root. **(5+5)**

3. (a) Derive the expression for the next approximation of a root of the function $f(x) = 0$ using Muller method. **(15+4)**

Once the new root is determined, mention which one of the initial three points should be discarded.

(b) Using Muller method determine the positive real root of $f(x) = x^3 - 14x - 13$ with guesses of $x_0 = 4$, $x_1 = 5$ and $x_2 = 4.5$. Show calculation only for two successive iterations. **(16)**

Contd P/2

EEE 423

4. (a) Prove that a polynomial can be expressed as, **(8)**

$$f(x) = f(0) + \frac{\Delta f(0)}{1!}x^{(1)} + \frac{\Delta^2 f(0)}{2!}x^{(2)} + \cdots\cdots + \frac{\Delta^n f(0)}{n!}x^{(n)}$$

where symbols have their usual meaning.

(b) Prove that divided differences are symmetric functions of their arguments. **(9)**

(c) Prove that $\delta^{2k} f(x_0) = \Delta^{2k} f(x_0 - kh)$; $k = 0, 1, 2, 3 \cdots$ **(8)**

where symbols have their usual meaning.

(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**.
Assume reasonable values for any data missing.

5. (a) Explain qualitatively, with the help of a graphical example, when spline interpolation is better than polynomial interpolation. **(8)**

(b) Fit the data given below, **(20)**

x	3	4.5	7	9
$f(x)$	2.5	1	2.5	0.5

with $f_1(x) = a_1x^2 - x + c_1, \quad 3 \le x \le 4.5$

$f_2(x) = a_2x^2 + b_2x + 18.46, \quad 4.5 \le x \le 7$

$f_3(x) = a_3x^2 + b_3x + c_3, \quad 7 \le x \le 9$

Estimate the value $f(5.75)$. Suggest a method that better fits this data.

(c) "An inverse interpolation problem is equivalent to a roots problem — explain this statement. **(7)**

6. (a) **(21)**

t	0	0.5	1	1.5	2	2.5	3
$y(t)$	11.1	10.1	9.3	10.9	10.1	9.3	11.1

Using polynomial regression, fit the above data with the model,

$$y(t) = 10 + b\sin(wt) + c\cos(wt), \quad \text{where } w = 2\pi/1.5$$

(b) A general linear least square model is given by, **(14)**

$$y = a_0z_0 + a_1z_1 + \cdots + a_mz_m \cdots (A)$$

Here, $z_0, z_1, \cdots, z_m$ are $(m + 1)$ basis functions and assume there are n number of data $(n \ge m)$.

Express equation (A) in matrix form as below,

$$\{Y\} = [Z]\{A\}$$

Now, using minimization of sum of residuals, derive the normal equation,

$$\left[[Z^T][Z]\right]\{A\} = \left[Z^T\right]\{Y\}$$

EEE 423

7. (a) What is the main source of error in Euler's method? Suggest a technique to minimize this error. **(5)**

(b) **(30)**

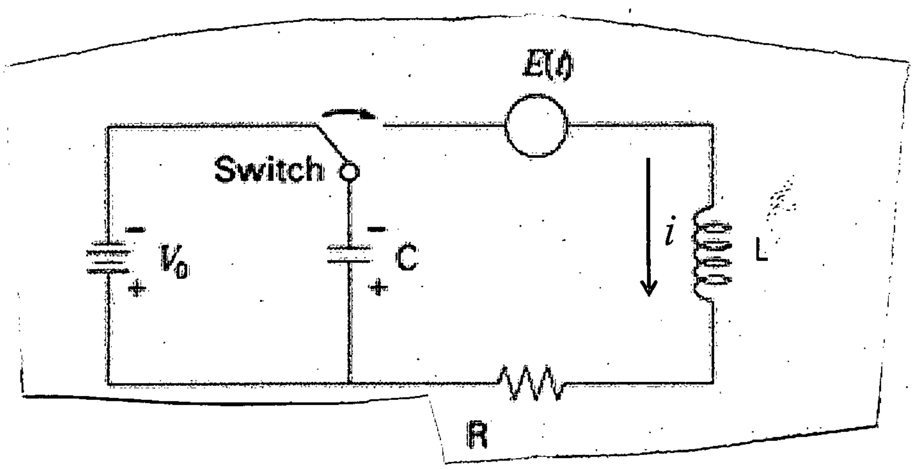

Fig. for Q. 7(b)

For the above circuit, the switch closes at t = 0. For $t > 0$, obtain solutions for i(t) and q(t) using second order Runge-Kutta method in the interval $t = 0$ to 0.3 s. Use step size, $\Delta t = 0.1$ s. Given, L = 1 H, C = 10pF, R = 10 kΩ, $E(t) = \sin(wt)$, $w = 141$ rad/s, $q(t=0) = 0.25$ C and $i(t=0) = 0$.

8. (a) Why is Simpson's1/3 rule more accurate than Trapezoidal rule? Explain graphically. **(7)**

(b) Suppose, the current density over a cross-section is defined as $J(x,y) = \sin\left[\frac{x}{16}\left(x^2 + y^2\right)\right]$ A/m^2. If the cross-section is 4×4 mm^2, calculate the total current flowing through the cross-section using Simpson's 1/3 rule. Use $\Delta x = \Delta y = 1\,mm$. **(28)**

Now, let's assume that the above conductor is replaced with a perfect electric conductor so that the current remains only on the boundary of the conductor of the same dimensions (4×4 mm^2). Also assume that the surface current can now be expressed by the same expression above. What will be the total current flowing through the cross-section in this case? Use Trapezoidal rule.

Note that the center of the cross sectional area coincides with the center of the coordinate system $[(x,y) = (0,0)]$.
