L-4/T-2/EEE **Date : 14/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Symbols have their usual meanings.

1. (a) Explain with necessary figure how latch up can be prevented in output pads by using guard rings. **(6)**

   (b) Explain with necessary figures how noise is filtered in an input pad. Draw the corresponding circuit. **(8)**

   (c) Draw the circuit diagram of a bi-directional I/O pad which has proper ESD protection and an enable signal that controls the input or output mode of the pad. Explain the operation of the circuit. Draw the optimized schematic diagram of the circuit. **(15)**

   (d) Show two possible alternatives that can be used for ESD protection in an input pad. **(6)**

2. (a) Draw the schematic diagram of a scan register comprising of a mux and a flip flop. Briefly explain its operation. **(10)**

   (b) Explain briefly with necessary diagram how boards are tested using boundary scan. **(10)**

   (c) Draw the gate level circuit for implementing the function $f = A \oplus B$ using NOT, AND and OR gates. Suppose you want to detect the stuck at 1 fault at all the primary inputs and the primary output (i.e., at A, B and f). Derive the corresponding minimum set of test vectors. **(15)**

3. (a) Write the equation of 50% delay, $T_{50\%}$, of a chain of cascaded drivers driving a large capacitive load. The drivers increase in size until the last device is large enough to drive the load. Find the number and size of the drivers for optimum delay and also determine the delay $T_{50\%}$ after using the drivers. **(24)**

   (b) In constant field scaling what happens to β, I_{on}, R, C, τ, f, E, P, A, P/A and I_{on}/A. **(11)**

4. (a) Derive an expression for the normalized logical effort and parasitic delay of an n-input NOR gate. **(6)**

   (b) Estimate the minimum delay of the path from A to B in Fig. for Q. 4(b) and choose transistor sizes to achieve this delay. The initial NAND2 gate may present a load of 8λ of transistor width on the input and the output load is equivalent to 45λ of transistor width. **(20)**

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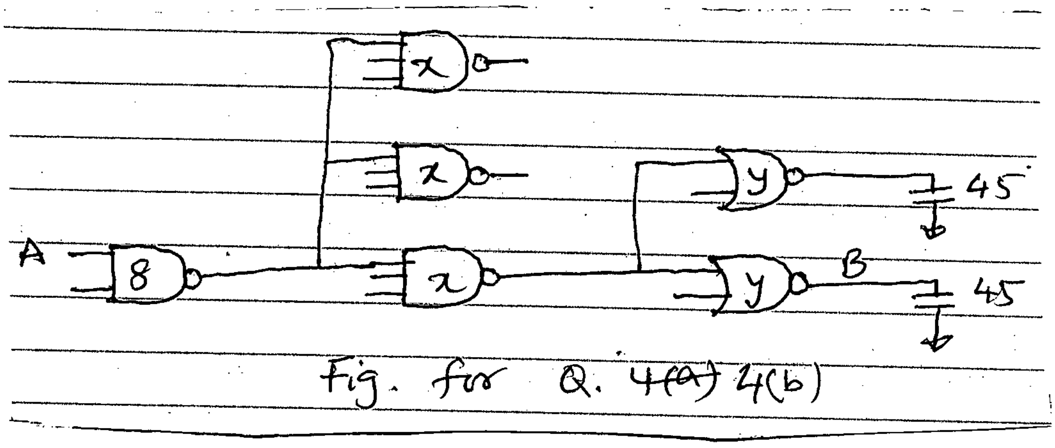
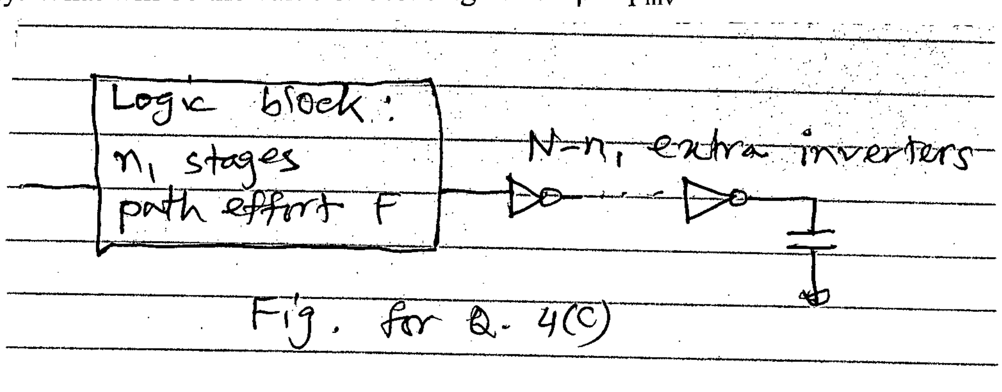
Contd ... Q. No. 4(b)



(c) Consider adding inverters to end of path as shown in Fig. for Q. 4(c). Write an equation for the delay in terms of best stage effort ρ, parasitic delay of the logic block and the parasitic delay of the inverters, p_{inv}. Find an expression after optimizing the delay. What will be the value of best stage effort ρ if $p_{inv} = 0$. **(9)**



SECTION – B

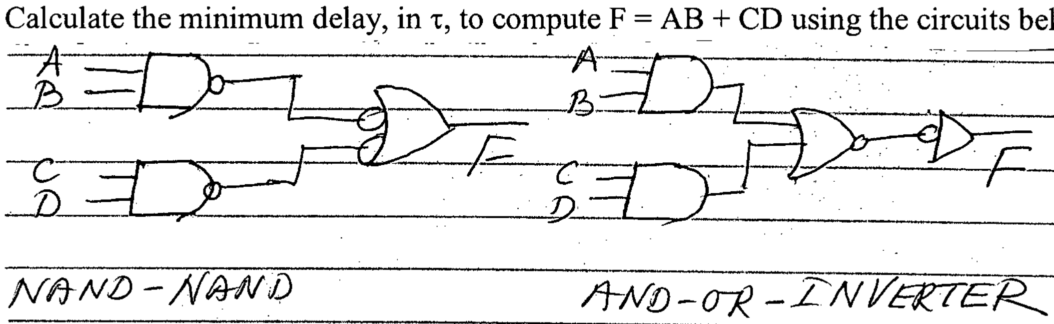
There are **FOUR** questions in this section. Answer any **THREE**.

5. (a) Calculate the static power dissipation of a 32-Word×48-bit ROM that contains a 5 : 32 pseudo-NMOS row decoder and PMOS pull-ups on the 48-bit lines. The PMOS transistors have an ON current of 360 μA/μm and are of minimum width (100 nm). $V_{DD} = 1.0$ V. Assume one of the word lines and 50% of the bit lines are high at any given time. **(5)**

(b) Explain why it is forbidden for one dynamic gate to drive another. **(5)**

(c) Draw the schematic diagram of an XOR/XNOR gate sharing transistors in dual rail domino logic. **(5)**

(d) Calculate the minimum delay, in τ, to compute F = AB + CD using the circuits below: **(20)**



Each input can represent a maximum of 20λ of transistor width. The output must drive a load equivalent to 100λ of transistor width. Choose transistor sizes to achieve this delay.

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6. (a) Draw the schematic diagram of a flip flop with asynchronous set and reset and explain its operation briefly. **(15)**

   (b) Derive the equation of minimum delay for (i) a flip-flop, (ii) a 2-phase latch, (iii) a pulsed latch considering no clock skew. Write the equation for the same configuration considering clock skew. **(20)**

7. (a) Explain with necessary diagram how delay can be reduced in a 4-bit ripple carry adder by omitting the inverters. **(5)**

   (b) Draw the schematic diagram of a carry-select adder and briefly explain its operation. **(15)**

   (c) Draw the schematic diagram of a carry skip adder and using the concept of carry generate and propagate, explain briefly how the adder works. Write the equation of delay (t_{skip}) for such an adder. **(15)**

8. (a) Draw the block diagram of a 3×3 rectangular array multipliers and show the basic building blocks. **(18)**

   (b) Multiply 10_{10} X(-14_{10}) using Radix 4 modified booth encoding. Take 5 bits for both multiplicand and multiplier and 10 bits for each partial product. **(17)**

L-4/T-2/EEE Date : 14/01/2017

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

The questions are of equal value.

1. (a) What is corona? Explain the positive corona discharge phenomena.

   (b) What is corona onset level? Find the value of ac critical onset voltage, E_0, when air pressure is 95 kPa and the air temperature is 16°C.

2. (a) With a neat sketch describe briefly the working principle of "Cockcroft-Walton" type multiplier circuit arrangement for generation of HVDC. Find the expression for voltage drop on load.

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

3. (a) Define "Impulse Voltage". Draw and explain lightning and switching impulses.

   (b) A single-stage impulse generator is shown in Fig. for Q. 3(b). Starting from first principle derive the expression for output voltage, the time for voltage rise to peak value and the voltage efficiency of the generator.

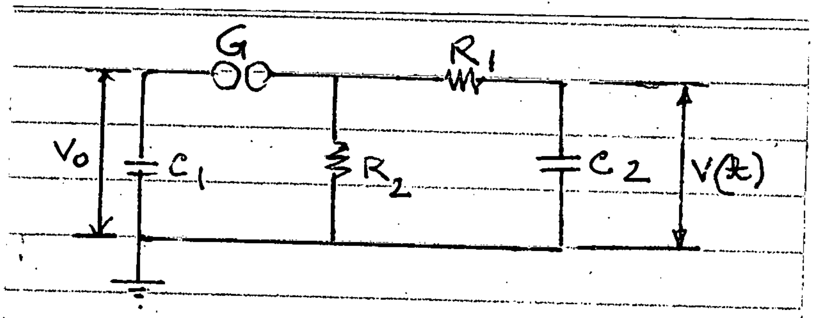

Fig. for Q.3(b)

4. (a) What are the different theories of dielectric breakdown of insulating liquids? Explain buble theory.

   (b) What is streamer mechanism of breakdown of gases? Discuss Townsend mechanism.

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SECTION – B

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

The figures in the margin indicate full marks.

5. (a) Describe erosion breakdown in solid dielectrics. Show the current and voltage waveshapes of erosion breakdown under ac voltage. **(20)**

   (b) A solid dielectric /specimen of dielectric constant of 4.0 shown in Fig. for Q. 5(b) has an internal void of thickness 1.5 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 occurs. **(15)**

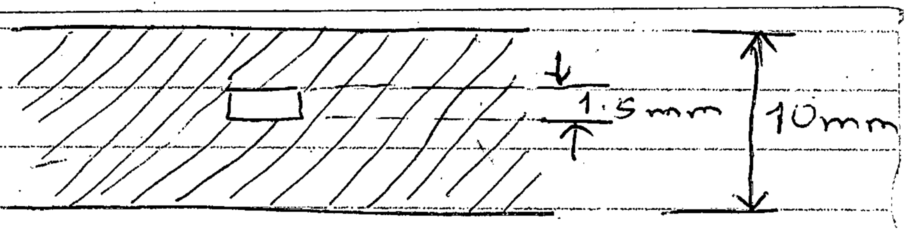

fig. for Q 5 (b)

6. (a) Define insulation coordination. With simple diagram describe the statistical method for insulation coordination in a power system. **(20)**

   (b) Classify insulation according to location. Explain the correlation between insulation and protection levels. **(15)**

7. (a) Explain the working principle of high voltage Schering bridge for measurement of capacitance and loss-tangent of a dielectric. **(18)**

   (b) Describe with a neat sketch the working principle of Van de Graaff Generator. **(17)**

8. (a) What are the methods used for high voltage measurements? Explain with a neat sketch the electrostatic voltmeter used for measurement of high DC and AC voltages. **(18)**

   (b) With a neat diagram, explain how a sphere-gap can be used to measure the peak value of high voltage. Describe in detail the parameters and factors that influence such voltage measurement. **(17)**

L-4/T-2/EEE Date : 14/01/2017

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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

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) Why are adjacent zones of protection made to overlap? **(7)**

   (b) Derive the equation for torque developed in an induction relay. **(14)**

   (c) What are the situations where DTOC relays are preferred over IDMT relays. **(7)**

   (d) How will you adjust the MTA of a directional relay? **(7)**

2. (a) Why is backup protection needed? **(7)**

   (b) Discuss the behaviour of a CT in deep saturation. What are its implications for the busbar differential protection? **(14)**

   (c) In the case of high impedance busbar differential scheme, how will you find out the minimum internal fault current for which the scheme will operate? **(14)**

3. (a) What are the various faults and abnormal operating conditions to which a turbo-alternator is likely to be subjected? **(8)**

   (b) Explain the transverse differential protection for detecting inter-turn faults on the same phase of generator winding. **(12)**

   (c) A 50-cycles, 3-phase alternator with grounded neutral has inductance of 1.6 mH per phase and is connected to busbar through a circuit breaker. The capacitance to earth between the alternator and the circuit breaker is 0.003 μF per phase. The circuit breaker opens when rms value of current is 7500 A. Determine the followings: **(15)**

      (i) Maximum rate of rise of restriking voltage.

      (ii) Time for maximum rate of rise of restriking voltage.

      (iii) Frequency of oscillations.

4. (a) Define making current and breaking current as applied to circuit breaker. **(8)**

   (b) Why resistance switching is used in air blast circuit breaker. **(8)**

   (c) Explain the followings: **(12)**

      (i) Effect of power factor on TRV

      (ii) Effect of natural frequency of TRV on rate of rise of TRV.

   (d) What are the disadvantages of bulk oil circuit breaker? **(7)**

Contd P/2

SECTION – B

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

The figures in brackets against each question indicate the marks.

All the symbols have their usual significance.

5. (a) What do you mean by bus bar layouts? What are the criteria for the choice of a bus bar layout? **(5+8)**

(b) Compare the advantages and disadvantages of a ring bus and a mesh arrangement. **(12)**

(c) Explain why inter-turn fault in a transformer cannot be detected by over current or differential relay? **(10)**

6. (a) How can over-fluxing occur and what are its effects on a transformer? Draw a typical transformer over-fluxing limit curve. **(3+2+4)**

(b) Explain using an operating time equation how can the numerical over current (OC) relays provide selectivity? **(8)**

(c) Explain for an analog (electromechanical) OC relay how does a higher plug setting slow down the relay? **(6)**

(d) Answer the following precisely. **(4×3=12)**

(i) How a line current is converted into a signal suitable for capturing by the data acquisition unit of a digital OC relay?

(ii) What is the usual sampling frequency of a current wave and how many samples are acquired per half cycle?

(iii) How the samples are used to calculate RMS current value by a DFT (Discrete Fourier Transform)?

(iv) How can you make a digital relay having an 8-bit A/D converter measure 63 times the relay CT's rated secondary current?

7. (a) Why do we need distance protection of a transmission line besides over current protection? Explain. **(10)**

(b) Write down the universal torque equation for a relay and derive from it the condition for a mho relay. **(12)**

(c) In a 132 kV power system a distance relay is connected at a substation SS1. The X/R ratio of each of the three lines (SS1 to SS2, SS2 to SS3 and SS2 to SS4) is 10 while their reactances are respectively 32, 32 and 48 ohms. Suppose the PT used has a ratio of 132 kV to 110 volts L-L and the CT used has a ratio of 200 : 1. Determine if the relay will trip for a 100 MW 0.8 lagging pf load flow through the line SS1 to SS2? **(13)**

Contd P/3

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8. (a) Suppose a CT ratio of 1000 : 5 is used on the delta side of a 230/23 kV Δ-Y power transformer. If the CT on the delta side measures the line current as 5 amps, find the CT ratio required on the Y side of the transformer for differential protection. Is it able to block trip of the differential relay? If not what should be done? **(5+3+5)**

(b) Prove that in the differential protection of a single phase transformer the CT ratios on two sides should be in inverse proportion of the transformer's primary and secondary turns ratio. **(10)**

(c) Answer the following precisely. **(3×2=6)**

(i) How can you prevent a differential relay trip on no load or inrush current of a transformer?

(ii) Is differential protection unit or non-unit type? Explain.

(iii) What type of relay is used in the spill current path of a differential protection scheme?

(d) For differential relay which one is needed- current magnitude or phasor? How it is computed in a numerical differential relay using N samples of each CT current? **(6)**

L-4/T-2/EEE **Date : 24/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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) Discuss basic transitions in semiconductors. What is Auger recombination? How Auger recombination affects performance of photo emitter and detector devices? **(15)**

   (b) Define ordinary and extraordinary waves. What should be the thickness of a quarter-wave quartz plate for a wavelength of 514.5 nm? Given that: **(10)**

   $\eta_e = 1.5533, \quad \eta_0 = 1.5442$

   (c) What is Kerr coefficient? Discuss the operation of a transverse pockels cell phase modulator. **(10)**

2. (a) With necessary diagrams, explain that carrier and optical confinement of DH laser is much better than homojunction or single heterojunction laser. **(15)**

   (b) What is the significance of slope efficiency of a laser diode? Discuss different types of mode hops in laser diodes. **(10)**

   (c) Consider a DFB laser operating at 1550 nm. Suppose that refractive index of the medium is 3.4. What should be the corrugation period for a first order grating and how many corrugations are needed for a first order grating if the cavity length is 20 μm. How many corrugations are there for second order grating? **(10)**

3. (a) What is detectivity of a photo detector? How can you improve detectivity of an APD? **(15)**

   (b) Draw and explain equivalent circuit of a photoconductor. Show noise spectrum for such detectors. **(10)**

   (c) Evaluate composition of $Al_xGa_{1-x}As$ that needs to be used for a detector whose cut-off wavelength is designed to be 0.7 μm. Given that **(10)**

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

   $= 1.425 + 1.247x + 1.147(x - 0.45)^2$ (indirect: $x > 0.45$)

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

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

Contd P/2

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4. (a) Discuss the significance of FF in a solar cell and explain how to improve this parameter. **(15)**

(b) Design a tandem solar cell in order to absorb in the spectral energy range of 0.8 eV to 2.2 eV. **(10)**

(c) Under illumination of 800 W/m^2 a Si p-n junction solar cell produces short circuit current of 100 mA at 10°C. What will be the open circuit voltage if temperature is increased to 50°C. Assume reverse saturation current density of the cell is 10^{-10} A and ideality factor is 1. **(10)**

SECTION – B

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

The symbols have their usual meaning.

5. (a) A 870 nm IR GaAs LED has an active layer that has been doped p-type with 2×10^{17} cm^{-3} of acceptors and has a nonradiative lifetime of about 100 ns. At a forward current of 30 mA, the voltage across it is 1.35 V and the emitted optical power is 6.5 mW. Calculate IQE, EQE, power conversion efficiency and light extraction ratio. For GaAs, direct recombination capture coefficient, $B = 2 \times 10^{-16}\ m^2s^{-1}$, $h = 6.626 \times 10^{-34}$ Js. **(20)**

(b) Draw the schematic pictures of planar surface emitting (a) homojunction (b) high intensity heterostructure LEDS showing suitable materials and substrates and also briefly describe the salient features of these LEDS. **(15)**

6. (a) A GaAs QW Laser is created by sandwiching a very thin GaAs QW between two wider bandgap semiconductor layers of AlGaAs. The QW depths from E_C and E_V are approximately 0.28 eV and 0.16 eV respectively. The thickness of QW is 10 nm. Find out the emission wavelength for this QW device. What is the change in emission wavelength with respect to bulk GaAs. Given Eg = 1.42 eV for GaAs and $m_e^* = 0.07\ m_e$, $m_h^* = 0.50\ m_e$, $m_e = 9.1 \times 10^{-31}$ kg. **(20)**

(b) Describe the operation of an EDFA mentioning relevant energy levels and wavelengths. **(15)**

7. (a) Find out the expressions for threshold gain coefficient and threshold population inversion for an optical cavity resonator laser. **(12)**

(b) A He-Ne gas laser operating at the wavelength 632.8 nm (equivalent ν_0 = 473.8 THz) has a tube length L = 40 cm and mirror reflectances of 95% and 100%. The line width $\Delta\nu$ is 1.5 GHz, loss coefficient α_s is 0.05 m^{-1}, the spontaneous decay time constant τsp is 100 ns and $n \approx 1$. What are the threshold gain coefficient and threshold population inversion? **(13)**

(c) What are homogeneous and inhomogeneous broadenings of the optical gain curve and line width? **(10)**

Contd P/3

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8. (a) A reverse biased pin photodiode is illuminated with a short wavelength light pulse from one side near the p+ region. The i-Si layer is 20 μm and the p+ layer is 1 μm thick. The diffusion coefficient of electrons in p+ region is 3×10^{-4} m^2s^{-1}. The saturation drift velocity in the depletion region is 10^5 ms^{-1} and the applied voltage is 60 . Find out the response time of this photodiode. **(13)**

(b) An InGaAs APD has a QE of 60% at 1.55 μm in the absence of multiplication (M = 1). It is biased to operate with M = 12. Calculate the photocurrent if the incident optical power is 20 nW. What is the responsivity when the multiplication is 12? **(12)**

(c) Draw the schematic diagram and explain the operation of separate absorption and multiplication (SAM) APD. **(10)**

L-4/T-2/EEE **Date : 24/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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**.

1. (a) Discuss the propagation characteristics of a wireless channel and find an expression for the channel impulse response. **(15)**

   (b) What are the different forms of the transfer function of a wireless channel? Explain their significance in evaluating the link performance. **(10)**

   (c) Derive the time-frequency auto-correlation of the transfer function of a wireless channel and define coherence bandwidth and coherence time. State their significances in relation to performance of a wireless communication system. **(10)**

2. (a) Discuss the following fading mechanisms and explain the signal channel conditions under which they occur: **(10)**

   (i) Flat fading
   (ii) Freq. Selective Fading
   (iii) Time Selective Fading
   (iv) Rayleigh Fading
   (v) Rician Fading

   (b) Considering a BPSK transmission over a Rayleigh faded AWGN channel, find the expression of average bit error rate (BER) and discuss the effects of fading on BER performance. **(15)**

   (c) State the methods of overcoming the effects of fading and delay spread in a wireless communication system. **(10)**

3. (a) What is meant by spreading of an spectrum? Explain how spread spectrum (SS) technique is useful for multiple user accessing of a common resource. **(10)**

   (b) Draw the block diagram of a direct sequence CDMA trans-receiver and show the waveforms at the output of each block. **(10)**

   (c) Find the expression for the SNIR and BER of a DS-CDMA wireless communication system with a number of simultaneous users. Plot the following performance curves and explain:

   (i) BER vs. no. of user with code length as a parameter. **(15)**

4. Write short notes (any Three) **(35)**

   (i) Frequency-Hopping (FH) CDMA.
   (ii) GSM Reference Architecture.
   (iii) Signal Processing in a GSM Mobile Station.
   (iv) GSM channels.

Contd P/2

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SECTION – B

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

The symbols have their usual meanings.

5. (a) Define-frequency reuse ratio, frequency reuse factor, co-channel interference. Write the expression of carrier to CCI ratio (C/CCI) for a hexagonal cell structure. Explain cell-splitting and cell-sectoring. How do they increase capacity? What is the increase in S/I ratio from omni antenna to using 120° directional antenna? **(2+2+2+2+4+4+1)**

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

   $$\frac{D}{R} = \sqrt{(3n)}$$

   (c) Consider a cellular system where C/CCI ratio of 23 dB is a requirement. Path loss exponent $\gamma = 4$. Determine Frequency reuse factor – **(4+4)**

   (i) Not assuming worst-case scenario

   (ii) Assuming worst-case scenario

6. (a) What is duplexing? Draw: FDMA-FDD, FDMA-TDD, TDMA-FDD and TDMA-TDD. **(2+3+3+3+3)**

   (b) Consider a cellular system in which one way bandwidth of the system is 25 MHz, channel spacing is 60 KHz and the guard band at each boundary of the spectrum is 20 KHz. Cell area is 6 Km^2, cluster size is 7, number of control channel is 48 and each time frame is divided into 8 slots. Calculate – **(15)**

   (i) Total number of available channel per cluster.

   (ii) Number of available channel for traffic.

   (iii) Spectral efficiency of the system (in units of channels/MHz-Km^2).

   (c) Briefly write about different diversity mechanisms. **(6)**

7. (a) What are the advantages of cellular system? **(2)**

   (b)Find the expression of SNR in maximal ratio combining. Also write the expression of probability density function (PDF) of SNR. What is the name of the PDF? Assume L independent Rayleigh fading channels. What is the problem of maximal ratio combining? **(8+3+2+2)**

   (c) Find the expression of probability density function (PDF) of SNR per bit under selection gain combining of L independent Rayleigh fading channels. Show improvement in SNR and BER performance with the increase of L. Also write the expression of BER. **(12+2+2+2)**

8. (a) What are the purposes of multi-carrier-modulation (MCM)? Distinguish between FDM and OFDM. Draw a block diagram of transmitting data with MCM using OFDM. Briefly explain the blocks required for OFDM. What is Cyclic-Prefix? **(3+3+3+3+3)**

   (b) Draw the block diagram of MC-DS-CDMA, MC-CDMA, and Modified MC-CDMA. Also draw the spectrum for Modified MC-CDMA. What is the total number of carriers required for Modified MC-CDMA? **(3+3+4+4+1)**

   (c) What is Hadamard Matrix? Construct H_2, H_4 and H_8. **(5)**

L-4/T-2/EEE **Date : 29/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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**.

All the symbols have their usual meanings.

1. (a) What are the requirements in making telecommunication standards? **(7)**

(b) What are the types of switching? Which one is preferable for voice communication and which one is preferable for data communication and why? **(8)**

(c) Describe the operating principle of a hybrid 2W/4W system. **(12)**

(d) Explain how the world wide subscribers obtain unique telephone numbers even the number of digits in the telephone numbers is limited? **(8)**

2. (a) Draw the Strowger step-by-step switching for a caller subscriber with number 34543. **(12)**

(b) A multistage switching system is shown in Fig. for Q. 2(b) which has 24 inlets. Determine **(15)**

(i) the total number of cross-points used in the system, and

(ii) the blocking probability using Lee graph when the utilization of an inlet is 0.2.

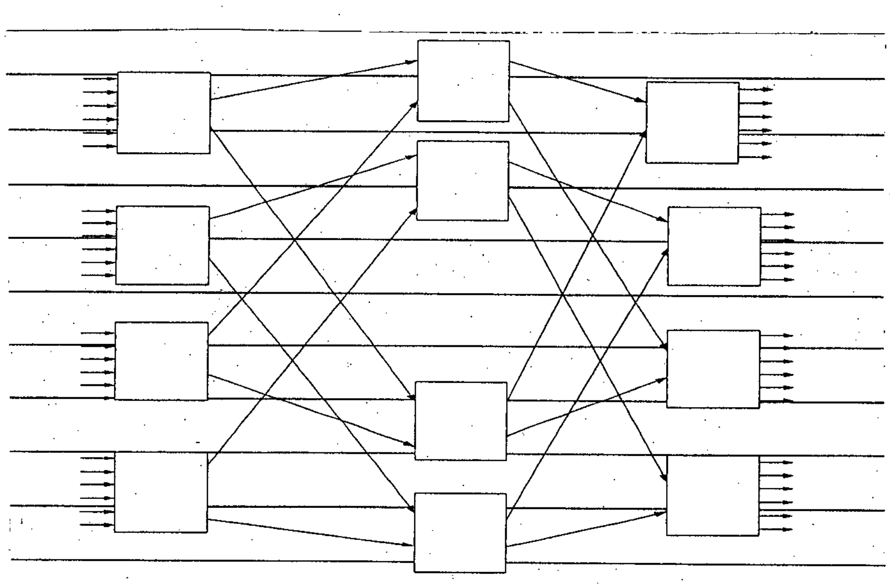

Fig. for Q. 2(b)

(c) What are the main problems in Lee graph-based blocking probability modeling? **(8)**

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3. (a) In analog TDS, the sampling frequency for each channel is 8000 Hz. The required time to set up a connection is 0.25 μs. Determine the number of channels supported by the system. **(8)**

(b) Describe the operation of a TSI circuit. What are the applications of this circuit? **(12)**

(c) Consider two independent bufferless switching systems with different traffic arrival rates where the blocked calls are cleared immediately. The holding time of each call of the both systems is 3 mins. Both the systems are designed considering GOS of 0.01. **(15)**

The numbers of trunks in the switching systems are 1 and 2, respectively. Determine the utilization factors of the systems? Which system has higher utilization factor and why? What is the probability that all the lines of the systems are free? What is the probability that all the lines of the system are busy?

4. (a) The steady state probability of a delay system is given by **(18)**

$$P(k) = \begin{cases} \dfrac{A^k}{k!} P(0), & 0 \le k \le N \\ \dfrac{A^k}{N!\, N^{k-N}} P(0), & k > N \end{cases}$$

where, $P(0) = \left(\sum_{k=0}^{N} \dfrac{A^k}{k!} + \dfrac{A^k}{N!} \cdot \dfrac{A}{N-A} \right)^{-1}$. Derive the expressions for Erlang's delay formula and the average delay.

(b) Consider two delay telecommunication systems: SYS1 and SYS2. Assume, each subscriber generates 2 calls in an hour and the average holding time of each call is 1 min. The existing numbers of subscribers in SYS1 and SYS2 are 9 and 12, respectively. The numbers of lines in SYS1 and SYS2 are 3 and 4, respectively. Suppose you are a new client. Which system will you prefer to be connected and why? **(17)**

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) Draw the ISDN reference model and describe its elements. **(10)**

(b) With necessary diagram, explain various types of service primitives between layer 2 and its adjacent layers of ISDN system. **(8)**

(c) What is SIP? Discuss its architectural elements. **(10)**

(d) Discuss various types of services supported by ATM system. **(7)**

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6. (a) Explain how IP telephony is different than the traditional digital telephony. **(10)**

(b) Why is jitter considered a critical issue in IP telephony? Discuss a solution used for overcoming jitter problem in practical IP telephony. **(13)**

(c) With necessary diagram, explain the steps how two H.323 clients can be connected for a call. **(12)**

7. (a) Draw the NNI header structure of an ATM system and explain its each field. **(10)**

(b) Define a cluster in a cellular network. Explain how co-channel cells can be identified located in different clusters of a cellular network with hexagonal cell structure. **(10)**

(c) A cellular system with hexagonal layout covers an area of 3000 km^2 and 600 channels. **(15)**

(i) Calculate system capacity if required SIR = 10 dB, path-loss exponent = 2, cell area = 4 km^2.

(ii) If the cell radius in part (i) is doubled, what will be the impact on the system capacity?

(iii) Calculate system capacity and SIR if cluster size = 2, path-loss exponent = 3, cell area = 4 km^2.

(iv) If the path-loss exponent in part (iii) is now changed to 4, what will be the impact on the system capacity and SIR?

8. (a) Draw the block diagram of a satellite repeater. Explain why a LNA is used in satellite repeaters. **(8)**

(b) Briefly explain the popular satellite orbits. **(12)**

(c) Consider a satellite downlink operating at a frequency of 6 HGz over a bandwidth 5 MHz. The satellite range is 22,000 miles and the transmit power is 250 W. Antenna noise temperature and the equivalent noise temperature of the receiver are 200 °K and 75 °K, respectively. Antenna gains of satellite and receiver are 20 dB and 10 dB, respectively. Loss due to a weather effect is 4 dB and satellite pointing loss is 1 dB. System operating temperature is 8 °C. Calculate – **(15)**

(i) EIRP,

(ii) carrier to noise (C/N) ratio at the output of the receiver antenna, and

(iii) required transmit power for achieving a C/N ratio equal to 20 dB.

L-4/T-2/EEE **Date : 29/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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**.

The symbols have their usual meanings.

1. (a) describe why the optical branch of crystal vibration cannot be excited in a monoatomic crystal. **(10)**

(b) Show that, in a one dimensional monoatomic crystal the phase velocity (v_{ph}) and group velocity (v_g) for any wavevector (k) is related by **(12)**

$$v_g^2 + \frac{4}{k^2 a^2} v_{ph}^2 = a^2 \frac{C}{M}$$

where M is the mass of each atom, a is the lattice parameter and C is the elastic force constant.

(c) If a signal has a frequency 1% greater than the cut-off frequency of the crystal, then what is the minimum value of the amplitude of the signal's wavevector ($|k|$)? The lattice constant of the crystal is a = 1.0 nm. **(13)**

2. (a) In a one dimensional diatomic crystal, find the relationship between the amplitude of vibrations of the two atoms in the acoustic and optical branches. **(10)**

(b) Show that, in a one dimensional diatomic crystal, for all wavevectors (k) of the optical branch in the first Brillouin zone, any two adjacent atoms move in the opposite direction. **(10)**

(c) Show that, in a one dimensional diatomic crystal oscillating at the optical branch Brillouim zone boundary ($k = \pi/a$), the atom with the larger mass oscillates and the atom with the smaller mass does not move at all. **(15)**

3. (a) Why Einstein's theory of specific heat fails to explain the experimental T^3 dependence of specific heat at low temperature? How does Debye theory explain this experimentally found behavior? **(18)**

(b) State and explain the Bloch theorem. Explain how allowed and forbidden bands are formed in a crystal using the Kronig-Penny model. **(17)**

4. (a) Define anisotropic effective mass and Zener oscillation. **(5)**

(b) Using tight binding model, show how bonding and anti-bonding molecular orbitals are created in a diatomic molecule. **(20)**

(c) Explain how forbidden energy bands in solid are formed using tight binding model. **(10)**

Contd ... P/2

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SECTION – B

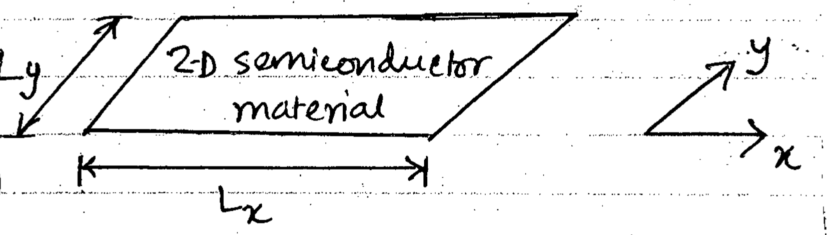
There are **FOUR** questions in this section. Answer any **THREE**.

List of equations is attached at the end of the question.

5. (a) Derive the general expression of probability amplitude within the Fermi's golden rule for scattering from an initial state 'i' to a final state 'f'. **(15)**

(b) Consider the two-dimensional (2-D) semiconductor material shown in Fig. (I). Show that the single-particle lifetime in this sample is independent of the size of the sample. **(10)**

Fig. (I)
Fig. for Q. 5(b)



(c) How would you realize a 'single-electron transistor'? Explain Coulomb-Blockade with respect to the current voltage relation in such a transistor. **(10)**

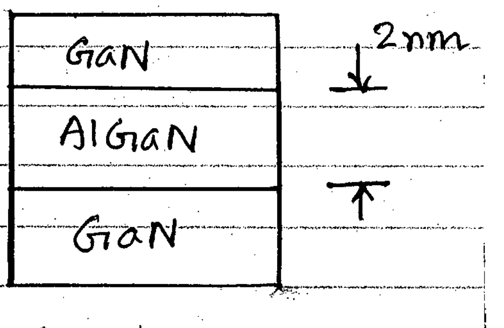
6. (a) Derive the expression of the scattering rate induced by a perturbation potential $\hat{V}(r)e^{i\omega_0 t}$ in a bulk semiconductor. If this perturbation is caused by a photon, does it correspond to photon emission or photon absorption? **(13)**

(b) Define distribution function used in the Boltzmann transport equation. Describe the evolution of the distribution function in the presence of electric and magnetic fields applied simultaneously. **(12)**

(c) Consider the GaN/AlGaN double-heterostructure shown in Fig. (II). Here the bandgaps of GaN and AlGaN are E_{g_1} = 3.4 eV and E_{g_2} = 4.5 eV respectively and the conduction band offset is $\Delta E_c = 0.8\ \Delta E_g$. **(10)**

Show that the minimum tunneling probability of an electron to tunnel through the AlGaN barrier is non-zero. What is the classical tunneling probability of an electron having 0.7 eV energy?

Fig. (II)
Fig. for Q. 6(c)



Contd ... P/3

EEE 461

7. (a) Show how scattering by photon leads to the concept of spontaneous and stimulated emission in a semiconductor. **(13)**

(b) Write down and explain the general expression of current flowing from the left to the right contact for the conduction band energy diagram shown in Fig. (III). Here μ_L and μ_R are the quasi-Fermi levels. **(12)**

Simplify your written expression of current if the bias voltage is made significantly high and at the same time the measurement temperature is brought down to 4K.

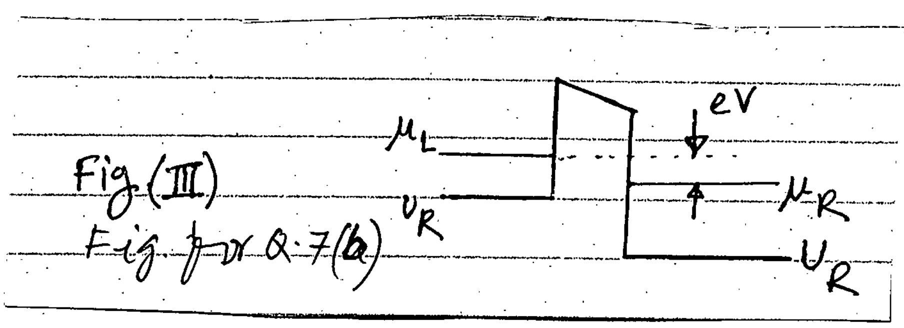


Fig.(III)
Fig for Q.7(b)

(c) Is conductance always dependent on the length of the current carrying path? Explain with an example. **(10)**

8. (a) What is the 'Born approximation'? Derive the scattering rate $W_{\bar{k}+\bar{q},\bar{q}}$ within this approximation, where $\hbar\bar{k}$ is the initial momentum and $\hbar\bar{q}$ is the momentum added by a scattering event. What is the relation between $\bar{k}$ and $\bar{q}$ if the scattering process is elastic in nature? **(12)**

(b) Quantum mechanically show that for a particle having mass m* and wavevector k, the current density is given by, $J = \dfrac{q\,\hbar k}{m^*}$. What will be the value of J if the particle is three-dimensionally confined within a box? Explain using relevant equation. **(10)**

(c) The scattering rates in a ternary semiconductor at 100K temperature are the following **(13)**

Ionized impurity scattering rate = $2 \times 10^{12}\ s^{-1}$

Neutral impurity scattering rate = $10^{10}\ s^{-1}$

Alloy scattering rate = $10^{12}\ s^{-1}$

Photon scattering rate = $10^{11}\ s^{-1}$

If a transistor is fabricated using this semiconductor and operated at a temperature of 300 K, calculate the expected conductivity in accordance with the Drude model. Assume that the concentration and effective mass of the majority carriers in this device are $5 \times 10^{15}\ cm^{-3}$ and $0.5\ m_o$ (where $m_o = 9.1 \times 10^{-31}$ kg) respectively under the operating conditions.

List of Equations

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

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

$$R_B = \frac{2R - 2R\cos(2k_2d)}{1 + R^2 - 2R\cos(2k_2d)}$$

$$T_B = \frac{T^2}{1 + R^2 - 2R\cos(2k_2d)}$$

$$J = \frac{q\hbar}{2mi}\sum_n\left(\Psi_n^*(\nabla\Psi_n) - \Psi_n(\nabla\Psi_n)^*\right)$$

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

$$\langle f | H' | i\rangle = \frac{ie\hbar}{m}\langle f | \bar{A}.\nabla | i\rangle$$

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

L-4/T-2/EEE **Date : 29/01/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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

Full Marks : 210 Time : 3 Hours

The figures in brackets against each question indicate the 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 significance.

1. (a) Explain the features that must be incorporated in a traditional power system in order for it to be labeled as smart grid? What are the main barriers for implementing smart grid in Bangladesh? **(8+3)**

(b) What do you mean by forward contracts in electricity market? **(4)**

(c) Suppose the on-line offers received from three GenCos and the bids received from two DisCos by the ISO at 10 am for 11 am on a day are as follows: **(10+5+5)**

Offers	Gen Co 1			Gen Co 2			Gen Co 3			Bids	Dis Co 1				Dis Co 2			
Block	1	2	3	1	2	3	1	2	3	Block	1	2	3	4	1	2	3	4
Power MW	5	12	13	8	8	9	10	10	5	Power MW	13	10	10	8	12	9	9	8
Price $/MWh	1	3	3.5	4.5	5	6	7	9	10	Price $/MWh	20	15	7	5	18	16	11	5

Assume that there is no constraint on the capacity of transmission lines, minimum output and ramping rate of the generation units. Using a plain graph paper determine the MCP and prepare a Table showing offers and bids going to be the finally accepted corresponding to this MCP. Also calculate the social welfare for the hour.

2. (a) In addition to inertial response (stored energy in rotor mass) and primary control, how can frequency be controlled in the event of generation loss in (i) a vertically integrated system and (ii) an electricity market? **(4+4)**

(b) Starting from the first principle and using a DC model derive a matrix equation expressing the line flows in a power system in terms of the branch-to-node incidence matrix, branch reactance matrix, bus susceptance matrix and bus injections. **(14)**

(c) Form the generation outage sensitivity matrix $[S_f]$ for a 230 kV system with the following specifications. The parameters are on a 100 MVA base. The generators are at buses 1, 2, 4 with bus 4 as the slack bus. **(13)**

Line 1: bus 1 to 2; x = 0.01 pu. Line 2: 2 to 3; x = 0.02 pu. Line 3: 1 to 3; x = 0.01 pu. Line 4: 2 to 4; x = 0.025 pu.

Contd P/2

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3. (a) What do you mean by preventive and corrective control? Explain giving examples of such control actions. **(10)**

(b) In a 5- bus 3- generator system bus 5 is the slack. The other two generators are connected at bus 3 and 4. Each generator has a maximum limit of 1500 MW and a minimum limit of 250 MW. The loads connected at buses 1 and 2 are each 1000 MW. Write down the complete OPF formulation using DC model and involving both preventive and corrective measures to reduce overloading of the lines in case the line 1-3 becomes out. $P_{G3} = 1000$ MW, $P_{G4} = 600$ MW. **(17)**

The line information is as follows.

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

The bus suscceptance matrices with the line 1-3 connected and out are respectively:

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

(c) What are the ways to make preventive controls dominant over corrective controls in an OPF solution? **(8)**

4. (a) Prove that the line outage sensitivity factor between a line m-n and an outaged line i-j can be expressed in terms of 4 generation outage sensitivity factors. **(12)**

(b) Explain the advantages and disadvantages of RI method and 1 iteration FDLF method for contingency ranking. **(13)**

(c) What are the difference between reliability and security of a power system? **(10)**

SECTION – B

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

5. In a small power system there are two stages in a load cycle (each one in 4 hours long) and four generating units. In the last stage load is 1100 MW and in the first stage load is 1600 MW. Only units 1 and 2 are to operate in the last stage of load cycle.

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Contd ... Q. No. 5

(i) Based on Table 1 and 2 calculate power supplied by generators in the last stage of load cycle and the corresponding production cost. **(12)**

(ii) Assume that the startup cost of each thermal generating unit is \$3500 and the shut down cost is \$1500, determine the optimal unit commitment policy of four thermal units for two stages. **(23)**

$P_1(1)$ = \$ 70,908, $P_2(1)$ = \$ 68,976, $P_3(1)$ = \$ 67,856, $P_4(1)$ = infeasible

Use the production cost for stage 2 obtained in 5(i). Here, $P_m(n)$ = production cost of combination x_m in the stage 'n' of the load cycle. Use backward dynamic programming approach.

Table 1 : 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 : Unit technical and economic parameter

Generating Unit	Min (MW)	Max (MW)	a_i \$/(MW)^{2}h	b_i \$/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

6. (a) Two thermal generating units are operating in parallel at 60 Hz to supply a total load of 700 MW. Unit 1, with a rated output of 600 MW and 4% speed-droop characteristics, supplies 400 MW and unit 2, which has a rated output of 500 MW and 5% speed droop, supplies remaining 300 MW of load. If the total load increases to 800 MW, determine the new loading of each unit and common frequency change before any supplementary control action occurs. Neglect losses. **(10)**

(b) A 50 Hz system consisting of the three generating units is connected to a neighbouring system via tie line. The units have ratings of 300,500 and 600 MW and have speed droop characteristics of 5, 4 and 3% respectively. Suppose that a generator in the neighbouring system is forced out of service and tie line flow increases from scheduled value of 400 to 631 MW.

Contd P/4

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

(i) Determine the amount of increase in generation of each of three units and find ACE of this system, whose frequency bias setting is –58 MW/0.1 Hz. (Use the equation ACE = $(P_a - P_s) - 10\,B_f\,(f_a - f_s)$ MW). **(15)**

(ii) Suppose that it takes 5 minutes for AGC to command three units to increase their generation to restore system frequency. What is error in seconds incurred during 5-min period? **(3)**

(c) Explain "Supplementary Control action". **(7)**

7. Telemetered measurements on the physical system corresponding to Fig. for Q. No. 7. The per unit values of five measured quantities are

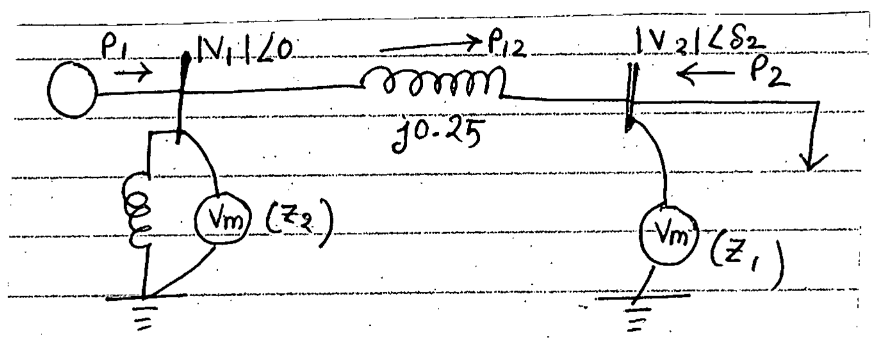

Fig for Q No. 7

$|Z_1| = |V_2| = 0.92$, $|Z_2| = |V_1| = 1.02$, $Z_3 = Q_1 = 0.605$, $Z_4 = P_{12} = 0.598$, $Z_5 = Q_{21} = 0.305$

Given that,

$$h_1\,(x_1^{(k)}, x_2^{(k)}, x_3^{(k)}) = x_2^{(k)}$$

$$h_2\,(x_1^{(k)}, x_2^{(k)}, x_3^{(k)}) = x_3^{(k)}$$

$$h_3\,(x_1^{(k)}, x_2^{(k)}, x_3^{(k)}) = \frac{25}{3}\,x_3^{(k)^2} - 4x_3^{(k)}\,x_2^{(k)}\cos x_1^{(k)}$$

$$h_4\,(x_1^{(k)}, x_2^{(k)}, x_3^{(k)}) = -4x_3^{(k)}\,x_2^{(k)}\sin x_1^{(k)}$$

$$h_5\,(x_1^{(k)}, x_2^{(k)}, x_3^{(k)}) = 4x_2^{(k)^2} - 4x_3^{(k)}\,x_2^{(k)}\cos x_1^{(k)}$$

(i) Find the Jacobian matrix $H_x^{(0)}$. **(10)**

(ii) Using flat start values compute least square estimates of state variables $x_1 = \delta_2$, $x_2 = |V_2|$, and $x_3 = |V_1|$ after one iteration. The gain matrix $G_x^{(0)}$ given by **(13)**

$$G_x^{(0)} = \begin{bmatrix} 7.111 & 0 & 0 \\ 0 & 9 & -8.3333 \\ 0 & -8.3333 & 9.6944 \end{bmatrix} X10^4$$

Contd P/5

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Contd ... Q. No. 7

(iii) The variances of the measurement errors are specified in per unit as **(12)**

$$b_1^2 = b_2^2 = (0.01)^2 \qquad b_3^2 = b_5^2 = (0.02)^2 \qquad b_4^2 = (0.015)^2$$

Identify the bad data.

Given that

$$H_x G_x^{-1} H_x^T R^{-1} = \begin{bmatrix} 0.5618 & x & x & x & x \\ x & 0.4976 & x & x & x \\ x & x & 0.5307 & x & x \\ x & x & x & 0.9656 & x \\ x & x & x & x & 0.4443 \end{bmatrix}$$

8. (a) Write short note on Smart Grid. **(7)**

(b) Explain differences between "RTU" and "IED". **(13)**

(c) Explain basic structure of SCADA and hierarchical control of power system. **(15)**

L-4/T-2/EEE **Date : 04/02/2017**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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) Discuss the dynamic behavior of a PMMC meter movement with necessary mathematical expressions. **(13)**

(c) Describe the mechanisms of damping in a PMMC meter movement caused by electromagnetic induction. Then, define *CDRX.* **(12)**

2. (a) Illustrate 'Accuracy' and 'Precision' with proper sketches, in relation to measuring instruments. **(12)**

(b) A typical ac voltmeter section of a commercial multimeter is shown in Fig. for Q. No. 2(b). The meter movement has an internal resistance of 250 Ω and require 1 mA for full-scale deflection. The shunting resistor, R_{sh}, has a value of 100 Ω. The diodes each have a forward resistance of 50 Ω and an infinite reverse resistance. 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; (ii) the ohms-per-volt rating of this ac voltmeter. **(23)**

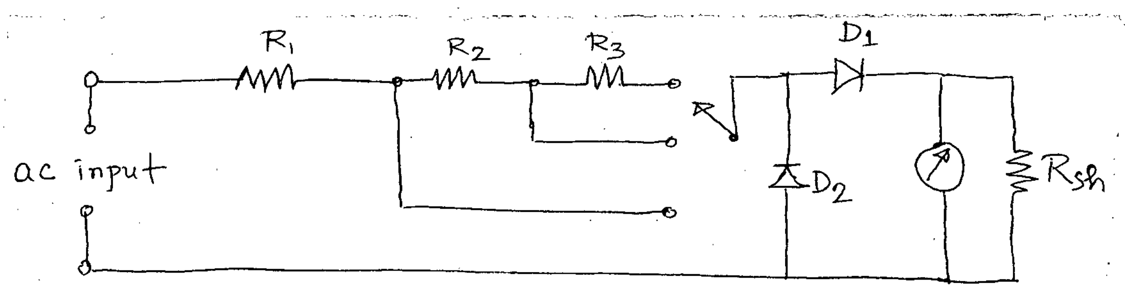

Fig. for Q. No. 2(b)

3. (a) Discuss the construction of a single-phase induction type energy meter with a neat sketch. **(10)**

(b) Explain with proper mathematical derivations, how an electrodynamometer type voltmeter is able to measure the true rms value of a voltage, irrespective of its waveform. **(12)**

Contd P/2

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Contd... Q. No. 3

(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 at full-load. **(13)**

4. (a) The speed of an 8-bit single-slope or ramp ADC is limited by the counter used in the converter. The converter has a maximum speed of 4×10^7 counts per second. Estimate the maximum number of A/D conversions per second that can be achieved with this ADC. Will the process be actually faster or slower and why? **(16)**

(b) Define the response parameters of a 'Sample and Hold' circuit. **(9)**

(c) A practical 'Sample and Hold' circuit is shown in Fig. for Q. No. 4(c). The maximum charging current of the input op-amp is 100 mA. If the expected droop rate is 1 mV/s and the acquisition time for a 3 V step is 6 μs, calculate the droop current. **(10)**

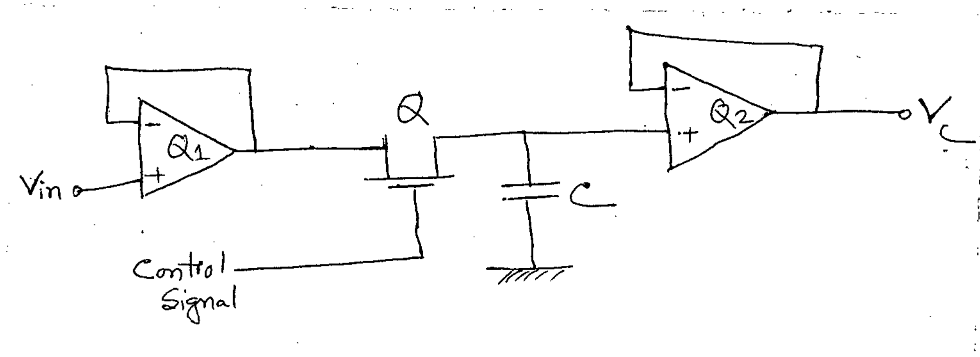

Fig. for Q. no. 4(c).

SECTION-B

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

Symbols have their usual meaning. Make necessary assumptions if needed.

5. (a) A linear variable differential transformer (LVDT) configuration is shown in Fig. for Q. 5(a). **(25)**

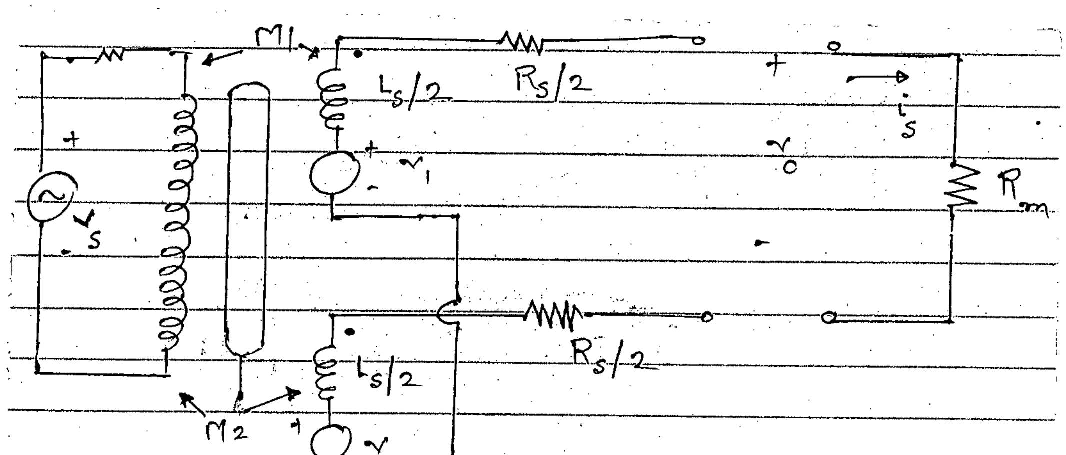

Fig. for Q. 5(a)

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Contd... Q. No. 5

(i) Now, for the above configuration, plot v_0 qualitatively if v_s is a pure sinewave starting at t = 0. (You have to plot for core above null, at null and below null cases).

(ii) Next, suppose v_s is connected to a variable frequency source which can vary its frequency from very low to very high values. Plot the phase angle of the system (shift between input and output) as a function of driving frequency, approximately.

(ii) If you want DC output from Fig. for Q. 5(a), make necessary changes to redraw the circuit and plot waveshapes at each points.

(b) Suppose as a designer, you need a circuit which will produce a current, directly proportional to the angular velocity, $\omega = \frac{d\Theta}{dt}$ of a rotating body. Draw such a configuration, explain it and plot the sensitivity of the device within the operating range. **(10)**

6. (a) An inductive pressure transducer and its transfer characteristics are shown in Fig.; for Q. 6(a). Do you think the plot is correct considering the circuit? If yes, explain how. On the other hand, if you think no, make changes to the circuit to obtain the output. **(17)**

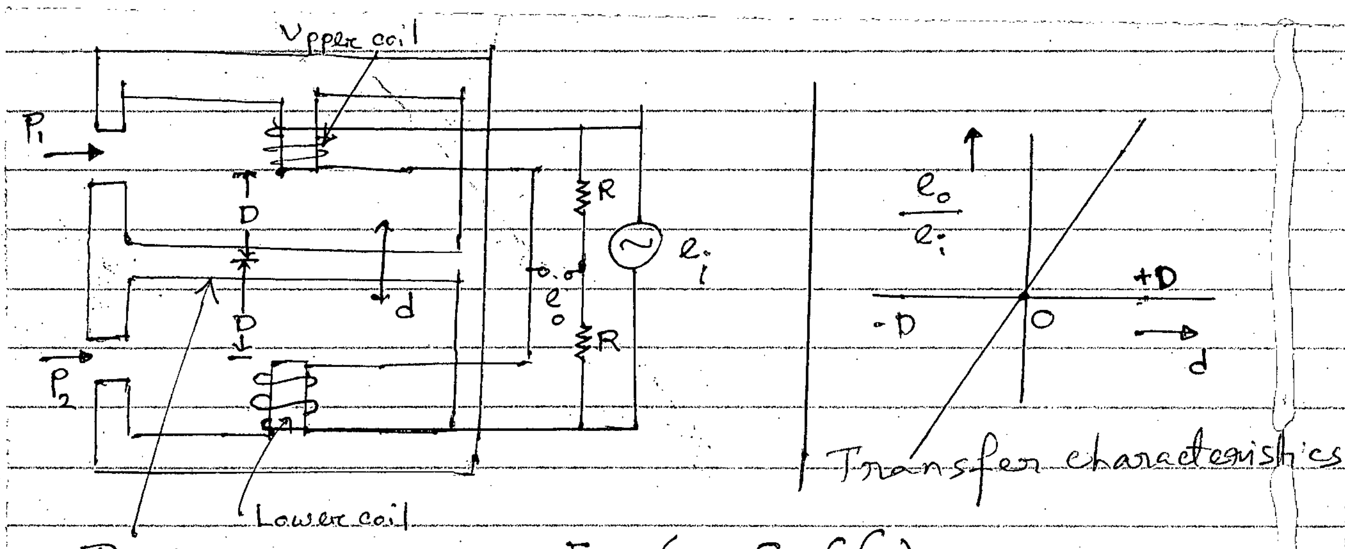

Fig. for Q. 6(a)

(b) Fig. for Q. 6(b) shows an ultrasonic flowmeter configuration. **(18)**

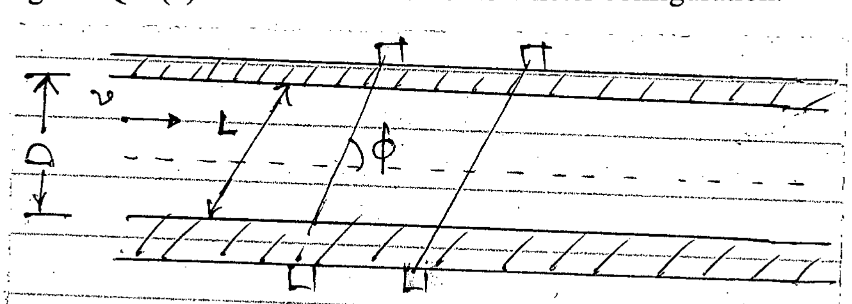

Fig. for Q. 6(b)

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

It suffers from 2 problems-flow velocity measurement will vary upon velocity of sound and flow velocity and output are not explicitly linearly related. Can you modify the circuit and measurement system to solve these problem? Explain how it works.

7. (a) In what ways electrical interference noise can enter a measurement system? Explain them briefly and suggest remedies in short. **(15)**

(b) Suppose you have 3 signals as- **(20)**

$x_1(t) = \frac{w_1}{\pi}\sin c\frac{w_1 t}{\pi}$, $x_2(t) = \exp[jw_2 t]$ and $x_3(t)$ where $|X_3(\omega)|$ is shown in Fig. for Q. 7(b).

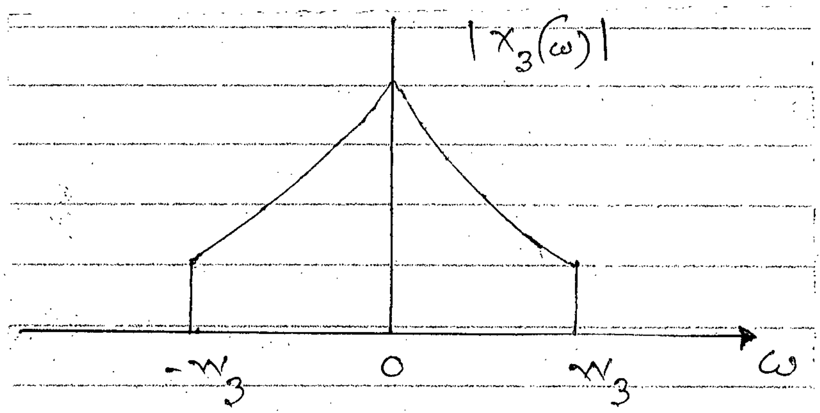

Fig. for Q. 7(b)

Draw the block diagram and magnitude spectrum (to scale) for a FDM system both at the transmitter and receiver end. Also, mention the conditions of carrier frequency choice to avoid aliasing.

8. (a) Suppose you are testing the bending properties of a bone using two identical strain gauges in the setup given in Fig. for Q. 8(a). R_{GO} = nominal resistance at zero strain. **(20)**

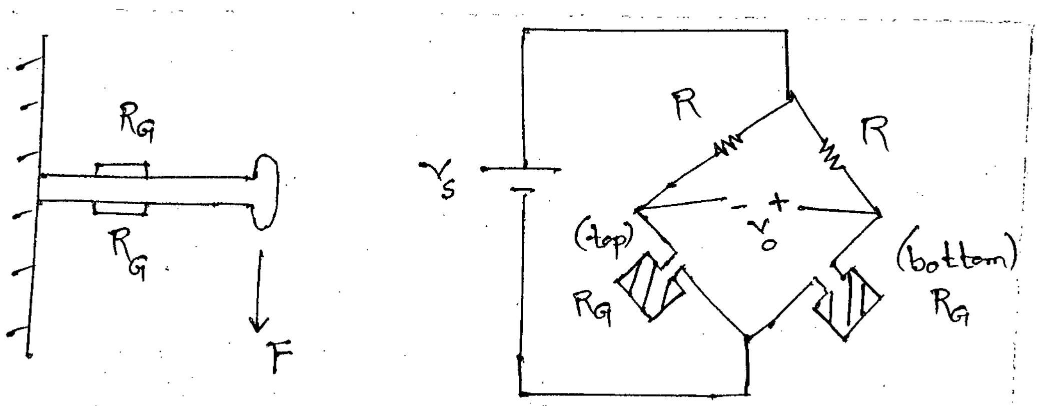

Fig. for Q. 8(a)

(i) Derive the sensitivity $\frac{v_0}{\varepsilon}$ (ε = strain), in terms of v_s, R, R_{GO} and gauge factor G.

(ii) Assuming R = R_{GO}, what is the effect of temperature increase in case (i)?

(iii) For your applications, you want strain to be ~5%. What should be the gauge factor to achieve 0.1 V output with 10 V source, using the case in (ii).

Contd P/5

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Contd... Q. No. 8

(b) A resistance R is measured using connection in Fig. for Q. 8(b). The current measured is 10 A on range of 10 A and voltage measured is 125 V on 150 V range. The scales of the ammeter and voltmeter are uniform, the total scale divisions of ammeter and voltmeter are 100 and 150, respectively. The scales are such that 1/20 of a scale division can be distinguished. The constructional error of the ammeter is ±0.5% and that of voltmeter is ±0.3%, the resistance of the ammeter is 0.5 Ω. Calculate R and the limits of possible error in the results. **(15)**

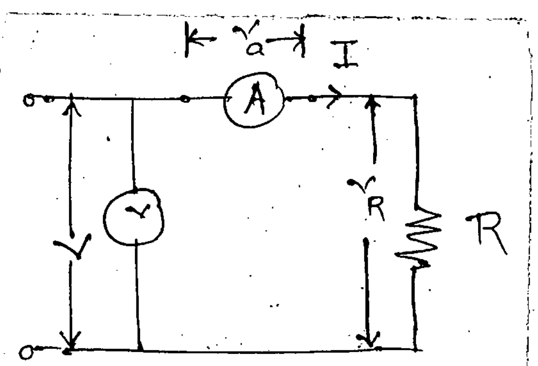

Fig. for Q. 8(b)

L-4/T-2/EEE Date : 04/02/2017

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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) Explain the frequency dependency of tissue impendence. Describe how changing tissue volume can be measured by impedance plethysmography. **(15)**

   (b) "Noise in biosignal must be removed before diagnosis" – explain with typical examples. **(10)**

   (c) Discuss how shape, size, material and energy requirement of an electrode affect signal measurement. **(10)**

2. (a) Classify bioelectric transducers. "Bioelectric electrodes are also transducers" – explain with example. Describe the function of PZT in ultrasonography. **(15)**

   (b) With block diagram, describe the working principle of different parts of X-ray machine. **(15)**

   (c) Describe the construction of Ag-AgCl electrode. **(5)**

3. (a) Define the components of blood tested for general diagnosis. Describe the operation of spectrophotometer and flow cytometry cell counter. **(20)**

   (b) Describe the basic physics and interaction of fields in MRI. **(10)**

   (c) Write a short note on isotopes used in nuclear medicine. **(5)**

4. (a) Define scintigraphy and write its uses. Briefly descriobe the techniques of CT, PET and SPECT. **(20)**

   (b) Define surface and intramuscular EMG with their measurement and importance in muscle pain diagnosis. "EMG is present in most of other biosignals as noise" – explain. **(15)**

Contd P/2

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SECTION – B

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

Symbols have their usual meanings.

5. (a) Explain how sampling of digitized ECG influences HR based diagnosis. Describe the importance of ETT-band diagnosis of cardiac abnormalities. **(15)**

   (b) What information do we get from the frequency, content of HRV? With examples explain how HRV can be used as a diagnostic tool. **(10)**

   (c) Define bioelectric potential and describe the significance of each potential level in a typical cycle of it. **(10)**

6. (a) What is an ECG lead? Describe the importance of 12 leads in ECG- based diagnosis, and write the information that can be obtained from each of the limb leads. **(20)**

   (b) Briefly describe the factors that alter normal ECG. Discuss the importance of coordination among different ECG waves. **(15)**

7. (a) Define cardiac pacemakers. Explain the control of cardiac rythm by ANS. Describe the importance of artificial pacemakers to control cardiac rythm. **(15)**

   (b) Briefly describe blood pressure and its parameters. Describe the operation of a systolic pressure detector circuit. **(15)**

   (c) What are heart sounds? What information can we have from abnormal heart sounds? **(5)**

8. (a) Briefly describe the measurement technique of EEG. Next, discuss different EEG waves and their importance in psycho-physiological behaviour. **(15)**

   (b) Define intervals and segments of an ECG signal. Why is T-wave positive in human beings? **(10)**

   (c) Define bundle block. With neat sketches, show changes in ECG due to bundle block. **(10)**

L-4/T-2/EEE Date : 04/02/2017

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2014-2015

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? **(9)**

(b) Briefly discuss about algorithmic error that may occur in numerical calculations. **(8)**

(c) Derive the expression of relative error in result of a power calculation of a number in terms of its own relative error. **(8)**

(d) In the evaluation of $\frac{2.13 - 0.543}{34.1 \times 3.41}$ assuming maximum truncation error is each figure, estimate the limits between which the calculated value probably lies. **(10)**

2. (a) Derive the condition of convergence while finding a root of the equation f(x) = 0 by iterative method. **(8)**

(b) Derive the expression for the next approximation of a root of the non-linear function f(x) = 0 using Newton-Raphson method. Briefly discuss the limitations of this method to find the root. **(8+9)**

(c) Use 4-th order Taylor series expansion to approximate the function $f(x) = x^3 + \sin x$ from x = 0 with h = π/10. That is predict the function value at x = π/10. Also, calculate the percentage error in the predicted value. **(10)**

3. (a) Describe secant method to find root of a non-linear equation. **(10)**

(b) Write down the algorithm steps while finding the root of a non-linear equation using false-position method. **(8)**

(c) Derive the expression for the next approximation of a root of the function f(x) = 0 using Muller method. **(12)**

(d) Determine the first approximation of the non-zero real root of the equation $x^3 - 5x^2 - 25 = 0$ between 5 and 6 using Secant method. **(5)**

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

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

where, symbols have their usual meaning.

Contd P/2

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Contd ... Q. No. 4

(b) Prove that, **(8)**

$$\Delta^r x^{(n)} = n(n-1)(n-2)(n-3)\ldots(n-r+1)h^r x^{(n-r)}$$

where, symbols have their usual meaning.

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

(d) Construct a central 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**.

The symbols have their usual meanings.

5. (a) What are the differences between curve fitting and interpolation? What are the advantages of spline interpolation over polynomial interpolation? **(10)**

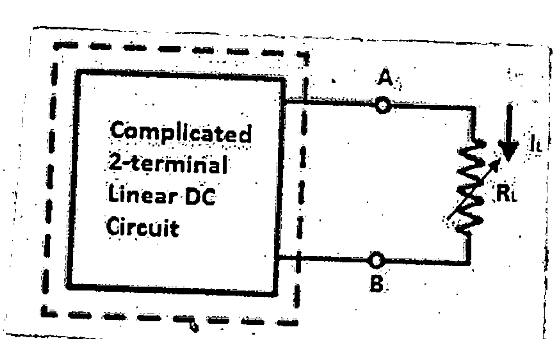
(b) Using the given data, determine the value of f(x) at x = 1.5 and the value of x for which f(x) = 0. **(25)**

x	0	1	2	4
f(x)	5	14	41	98

6. (a) With necessary figure(s) explain why minimum sum of error, minimum sum of absolute error and minimum error are ill-suited for regression. Which criterion is best suited for regression? **(10)**

(b) Derive the normal equations to fit a straight line through a set of data points (x_i, y_i). **(10)**

(c) Some readings of a laboratory experiment performed on the given circuit are shown in the chart below. Find the Thevenin equivalent circuit with reference to A-B terminals using suitable numerical approach. **(15)**



Load Voltage (V_{R_L}) Volts	Load Current (I_L) mili-Amperes
8.93	1
8.31	1.5
8.19	2
7.45	2.5
7.20	3

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7. (a) An experimental setup produces data at equal intervals of time. The data points are expected to form a sinusoid and N equidistant readings are taken over an estimated full cycle. Derive the necessary equations to determine the unknown coefficients from the least square model $y = A_0 + A_1 \cos \omega_0 t + B_1 \sin \omega_0 t$ fitted through the experimental data. **(15)**

(b) Values of a two variable function f(x, y) for different values of x and y are shown in the tabular form. Evaluate the integral: $\int_{x=0.5}^{x=2.0} \int_{y=0.1}^{y=0.3} f(x, y)$ using composite Trapezoidal Rule. **(20)**

x \ y	0.1	0.3	0.5
0.5	0.165	0.687	1.190
1.0	0.271	1.003	1.703
1.5	0.447	1.524	2.549
2.0	0.738	2.384	3.943

8. (a) For the circuit shown in Fig. for Q. 8(a) determine the value of $i_L(t)$ and $v_C(t)$ for the range of 0 to 1 sec. Use Euler's method with a step size of 0.25 sec. Given that, $i_L(0) = 1A$ and $v_C(0) = 6V$. **(20)**

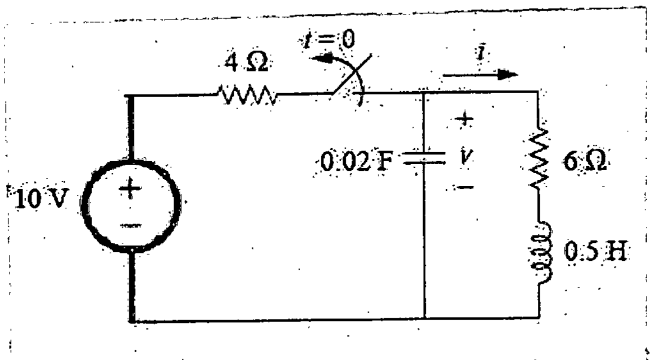

Fig. for Q. 8 (a)

(b) Find the value of y at x = 1 using Euler's method for the following equation. Use a step size of 0.25. **(15)**

$$\frac{dy}{dx} = x - y, \qquad y(0) = 1$$
