L-4/T-1/EEE **Date : 29/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B.Sc. Engineering Examinations 2018-2019

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) Why can temperature compensation be a necessity in a PMMC type meter? How can this be achieved? **(10)**

(b) A basic PMMC movement has an internal resistance of 5 Ω between terminals and full-scale deflection is obtained with a current of 15 mA. This movement is to be used with a shunt made of Manganin to measure 100 A at full scale at a particular temperature. Calculate the error caused by a 10°C rise in temperature, when: **(25)**

(i) the internal resistance of 5 Ω is due to Copper coil only.

(ii) the internal resistance of 5 Ω is comprised of a 4 Ω Manganin swamping resistance in series with a Copper coil of 1 Ω resistance.

The resistance-temperature coefficients of Copper and Manganin are 0.4%/°C and 0.015%/°C, respectively.

2. (a) Describe, with necessary diagrams and mathematical derivations, how a basic PMMC meter movement can be used to measure AC sinusoidal voltage and current. **(10)**

(b) How can the problem of non-linearity of a rectifier-based AC meter be reduced? Does this modification have any adverse effect on its performance? **(10)**

(c) A half-wave-rectifier-based AC (sinusoidal) voltmeter having a 100 μA PMMC meter movement is used in its 15 V range to measure the voltage across the 60 kΩ resistor in the circuit shown in Fig. for Q. No. 2(c). What is the voltage reading that the meter can show at the least, if the meter accuracy is ± 5% *fsd*? **(15)**

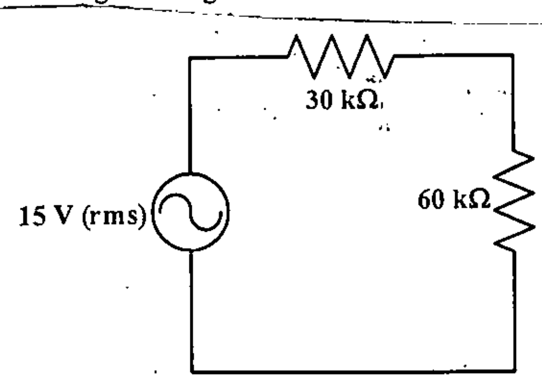

Fig. for Q. No. 2 (c).

3. (a) With necessary diagram and derivation, show that the steady-state deflection of a Spring-Controlled Electrodynamic Wattmeter is linearly proportional to the average power flow, irrespective of the waveforms of voltage and current. **(8)**

(b) What can be the functions of an 'Instrument Transformer? Describe, with necessary sketches, how a 'Clamp-on Ammeter' works. **(10)**

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Contd....Q. No. 3

(c) Why should the secondary of a CT not be open-circuited while its primary is energized? **(7)**

(d) Illustrate 'self-heating phenomena' in relation to a thermister operation. **(10)**

4. (a) Write down the advantages of electrical methods of transduction over their counterparts. **(10)**

(b) With a neat sketch, explain the operation of a displacement transducer that works on the principle of change in mutual inductance. **(10)**

(c) A five-plate capacitive transducer arrangement is shown in Fig. for Q. No. 4(c). The dimensions of each plate are $25 \times 25\ mm^2$ and the distance between successive plates is 0.25 mm. This arrangement is to be used to measure displacement x by measuring the capacitance, C, between the fixed and the movable electrodes. Find the relation between C and x. Draw the sensitivity vs. displacement curve for this transducer. **(15)**

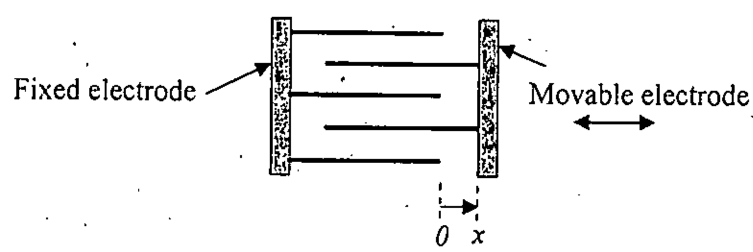

Fig. for Q. No. 4 (c)

SECTION – B

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

5. (a) Briefly describe the working principle of an 'Anemometer'. Show that, for an anemometer,

$$a + b \cdot \upsilon_f^c = f(i, T_w, T_f)$$ **(14)**

where all the symbols have their usual meanings.

(b) Briefly explain the capacitive methods for the measurement of 'Liquid Levels'. **(14)**

(c) Briefly describe the advantages and disadvantages of a capacitive transducer. **(7)**

6. (a) Briefly describe the elements of the 'Signal Conditioning System'. **(14)**

(b) With proper diagrams, explain the implementation and operation of a 'Single Slope ADC'. **(14)**

(c) Briefly describe a capacitive pressure transducer. **(7)**

7. (a) What are the problems of using a Wheatstone Bridge in measuring low resistance? Give a proper solution to overcome those problems. **(14)**

(b) Show that, for a Maxwell's Inductance – Capacitance Bridge, $Q \equiv \omega R_1 C_1$

where all the symbols have their usual meanings. **(14)**

(c) Briefly explain the operation of a turbine flow meter. **(7)**

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8. (a) With proper diagrams, briefly describe the classification of the 'Base-Band Telemetry'. **(14)**

(b) 'In TDM, the synchronism between transmitter and receiver is critical to recover the original signals' – explain the statement with proper diagrams. **(14)**

(c) Briefly describe the desirable characteristics of an amplifier. **(7)**

L-4/T-1/EEE **Date: 24/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub: **EEE 431** (Digital Signal Processing 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** questions.

1. (a) Show that the mulitrate system of Fig. for Q. 1(a) is time-invariant and determine its transfer function. **(20)**

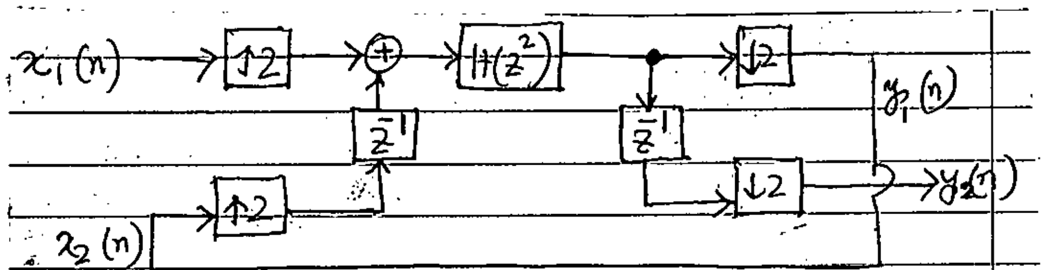

Fig. for Q.1(a)

(b) Prove the identity shown in Fig. for Q. 1(b). **(15)**

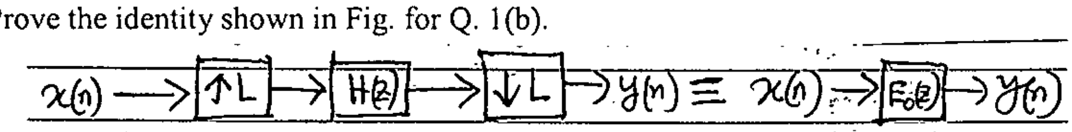

Fig. for Q.1(b)

2. (a) A suitable multirate FIR LPF is to be designed for extracting the baseline shifts in the fetal ECG. In this regard, the overall filter specifications for the decimator are: **(18)**

Passband ripple	0.01
Stopband ripple	0.001
Passband	0 – 0.4 Hz
Stopband	0.5 – 250 Hz
Sampling freq.	500 Hz
Decimation factor	500

(i) Design a single-state and a three-stage (25×10×2) decimator. Show the band edge frequencies for the decimating filter at each stage.

(ii) Calculate TSR and MPS to justify your choice for the suitable decimator.

(b) An unknown system is to be approximated by 4-th order linear phase FIR filter that satisfies the constraint, h(k) = h(4-k), using the system identification approach shown in Fig. for Q. 2(b). Summarize the modified RLS algorithm for this identification problem. Your answer must include the definitions of the cost function, signal and weight vectors, and the initial conditions required to illustrate the RLS algorithm. **(17)**

Contd P/2

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Contd. ... Q. No. 2(b)

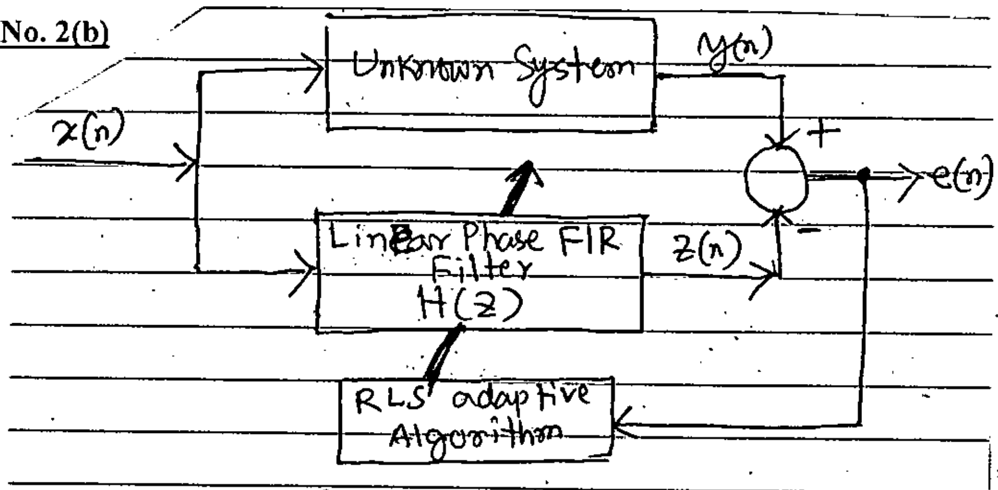

fig. for Q. 2 (b)

3. (a) A process x(n) is formed by passing white noise is $w(n)$ through an AR system that has a transfer function $H(z)=\dfrac{1}{1-0.08z^{-1}-0.9z^{-2}}$ **(17)**

The variance of the white noise is $\sigma_w^2 = 0.0342$. The LMS algorithm with two coefficients is used to estimate a process d(n) from x(n).

(i) What is the maximum value for the step size μ, in order for the LMS algorithm to converge in the mean?

(ii) What is the time constant for convergence? Assume $\mu\lambda_{max} = 0.1$.

(b) An autoregressive process is described by the difference equation **(18)**

x(n) = 1.8 x(n − 1) − 0.95 x(n − 2) + w(n) where w(n) is a white noise sequence with variance $\sigma_w^2 = 0.1$. Use the LMS algorithm to determine the parameters of a second-order (P = 2) linear predictor. Begin with $a_1(0) = 2$, $a_2(0) = 0$. Show the parameter update iterations for n = 1, 2, 3 using w(0) = 0.0919, w(1) = 0.6154, w(2) = − 0.4881, w(3) = − 1.7955 and x(0) = 0.0919, x(1) = 0.7809, x(2) = 0.8302, x(3) = − 1.0430.

4. (a) Consider a signal x(n) = s(n) + w(n), where s(n) is an AR(1) process that satisfies the difference equation S(n) = 0.8 S(n − 1) + v(n)

where v(n) is a white noise sequence with variance $\sigma_v^2 = 0.49$ and w(n) is a white noise sequence with variance $\sigma_w^2 = 1$. The processes v(n) and w(n) are uncorrelated. **(10+15+5)**

(i) Determine the autocorrelation sequences $r_{ss}(m)$ and $r_{xx}(m)$.

(ii) Design a Wiener filter of length M = 2 to estimate S(n).

(iii) Determine the MMSE for M = 2.

(b) Show that the following FIR linear-phase transfer function is a half-band filter: **(5)**

$$H(z) = -1 + 9z^{-2} + 16z^{-3} + 9z^{-4} - z^{-6}$$

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SECTION – B

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

5. (a) Determine the power spectrum for the random process generated by the following difference equation: $x(n) = \omega(n) - \omega(n-2)$ where $\omega(n)$ is a white noise process with variance σ_{ω}^{2}. **(16)**

   (i) Sketch the spectrum for the process.

   (ii) Determine the autocorrelation, $\gamma_{xx}(m)$, for the process.

   (b) An AR(2) process is described by the following difference equation:

$$x(n) = 0.81\, x(n-2) + w(n)$$

   where w(n) is a white noise process with variance σ_{ω}^{2}. **(19)**

   (i) Determine the parameters of the MA(2) and MA(4) models that provide a minimum mean-square error fit to the data of x(n).

   (ii) Plot the true spectrum and those of the MA(2) and MA(4) spectra. Compare the results and comment on the approximations.

6. (a) Determine the frequency and power of a single tone real sinusoid in white noise. The signal and noise correlation function is given as **(17)**

$$\gamma_{yy}(m) = \begin{cases} 3 \;, & m = 0 \\ 0 \;, & m = 1 \\ -2 \;, & m = 2 \\ 0 \;, & |m| > 2 \end{cases}$$

   (b) A signal x(n) consists of a pulsed sinusoid corrupted by a stationary zero-mean white noise sequence, i. e., $x(n) = y(n - n_0) + \omega(n);\ 0 \le n \le N-1$

   where w(n) is the noise with variance σ_{ω}^{2} and the signal is given by **(18)**

$$y(n) = \begin{cases} A\cos\omega_0 n, & 0 \le n \le M-1 \\ 0 \;, & \text{otherwise} \end{cases}$$

   The frequency ω_0 is known, but the delay n_0 (a positive integer) is unknown, and is to be determined by cross correlating x(n) and y(n). Assume that $N > M + n_0$ and $M >> \frac{2\pi}{\omega_0}$.

   (i) Determine $E\{r_{xy}(n_0)\}$ and $V_{ar}[r_{xy}(n_0)]$

   (ii) Evaluate signal-to-noise ratio (SNR).

   (iii) What is the effect of the pulse duration M on the SNR?

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7. (a) From measurements of a process x(n), it is estimated that the auto correlation sequence is $r_x(k) = \alpha^{|k|}$; $|k| \leq M$ where $|\alpha|<1$. Estimate the power spectrum of the process by using the Blackman-Tukey method with a rectangular window. **(12)**

(b) Let y(n) be a random process with power spectrum $P_y(e^{j\omega}) = P_x(e^{j\omega}) + P_\epsilon(e^{i\omega})$ where

$$P_\epsilon(e^{j\omega}) = \begin{cases} \frac{1}{\epsilon} & ; \quad |\omega - \omega_0| < \epsilon \\ 0 & ; \quad \text{otherwise} \end{cases}$$ **(23)**

(i) Find the entropy of y(n).

(ii) What is the entropy of this process in the limit as $\epsilon \to 0$?

8. (a) "The wavelet and sub band transform theories have significant linkages" – explain with mathematical details. **(15)**

(b) For the signal f = (2, 2, 4, 6, 8, 8, 12, 10), find its first-, second-, and third-level Haar transforms. Show that the sum of the energy of the wavelet coefficient is equal to that of the original signal. **(20)**

L-4/T-1/EEE **Date : 29/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **EEE 433** (Microwave 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**.
Smith chart has to be supplied. The symbols have their usual meaning.

1. (a) Show the entire electromagnetic spectrum of frequencies and indicate the microwave frequencies in the spectrum. **(4)**

(b) What are the advantages of using the microwave technology? Highlight on the major and commercial applications of microwave technology. **(4)**

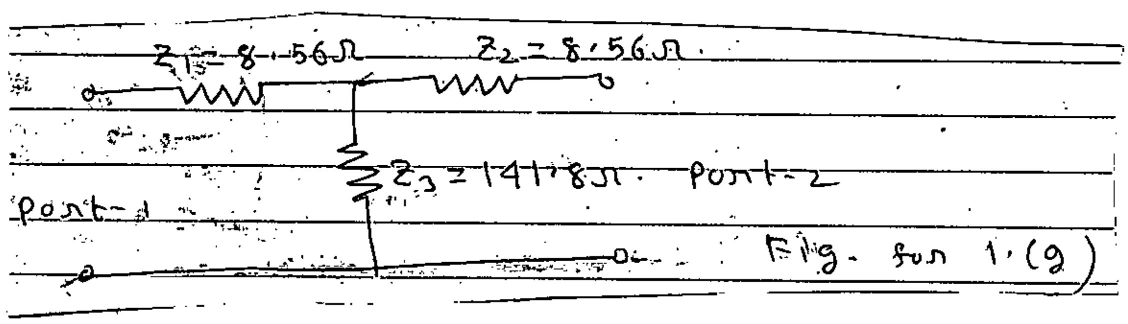
(c) What are the advantages of using microstrip line for interconnection? What are the factors that influence the characteristic impedance of a microstrip line? **(4)**

(d) Explain why dielectric filled waveguide does not support TEM wave? **(5)**

(e) A certain microstrip line has quartz ($\epsilon_{\pi} = 3.8$) as a substrate. If the ratio of line width (W) to substrate thickness is (W/h) = 4.5, determine the effective relative permittivity of the substrate and the characteristic impedance of the microstrip line for strip thickness (t) = 0.2 W. **(5)**

(f) Draw the sinusoidal current distribution of a center fed dipole antenna for the lengths (i) L= λ/2 (ii) L = 0.75 λ (iii) L = 1.5 λ (iv) L = λ and (v) L = 2 λ. **(5)**

(g) The circuit shown below is a matched 3 dB attenuation. Find the s-parameter of the circuit. Assume the output port is terminated by $z_0 = 50\ \Omega$. **(8)**



2. (a) For an ideally loss-less line show how a standing wave pattern is formed along the line terminated by a mismatched load (z_L). What is the separation between the location of a voltage maximum and the adjacent current maximum on the line? **(13)**

(b) Starting from the transmission line voltage and current equation, show that the time average power flow along the line at any point z is given by **(12)**

$$P_{av} = \frac{1}{2}\frac{|V_0^+|^2}{z_0}\left(1-|\Gamma|^2\right)$$

Also draw the voltage and current wave shapes of a short-circuited and open-circuited transmission line.

(c) A transmission line operating at 125 MHz has $z_0 = 75\ \Omega$, $\alpha = 0.02\ N_p/m$ and $\beta = 0.75$ rad/m. Find the line parameters R, L, G and C. **(10)**

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3. (a) Explain the impedance matching technique by a quarter wavelength transformer. **(10)**

(b) Starting from the input impedance expression of a two-wire transmission line show that

$$z_0 = \sqrt{ZscZoc} \text{ and } Y = \frac{1}{l} tanh^{-1} \sqrt{\frac{Zsc}{Zoc}}$$ **(10)**

All symbols have their usual meanings.

(c) A 50 Ω loss-less line is to be matched to an antenna with z_L= (75–j20) Ω using a shorted stub. Use the smith chart to determine the stub length and distance between the antenna and stub. **(15)**

4. (a) What is cavity resonator? What are the characteristics of a cavity resonator? For TE_{101} mode in an a×b×d rectangular cavity resonator, find the time average stored electric energy (W_e) and magnetic energy (W_m). Also, show that at resonance $W_e = W_m$, the field equations of the cavity resonator are given below: **(17)**

$$H_z = H_0 \cos\left(\frac{\pi}{a}x\right)\sin\left(\frac{\pi}{d}z\right), H_x = -\frac{a}{d}H_0 \sin\left(\frac{\pi}{a}x\right)\cos\left(\frac{\pi}{d}z\right)$$

$$H_y = 0 , E_x = 0, E_y = -j\omega\mu H_0\left(\frac{a}{\pi}\right)\sin\left(\frac{\pi}{a}x\right)\sin\left(\frac{\pi}{d}z\right)$$

(b) Define degenerate mode. For the cavity resonator as described in Q. 4(a), if (i) a>b>d (ii) a>d>b and (iii) a=b=d find the dominant modes of the cavity. **(8)**

(c) For an air filled cubic cavity resonator of 64 cm^3 with brass walls (a=1.57×10^7 S/m) determine (i) dominant mode and its resonance frequency for this cavity, (ii) Quality factor (Q) for TE_{101} mode and (iii) the time average electric and magnetic stored energy at the resonant frequency for TE101 mode. Take any assumption if necessary. **(10)**

SECTION – B

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

5. (a) Starting from the Maxwell's equations, prove that for a source free waveguide,

$$H_y = -\frac{1}{\gamma^2 + k^2}\left(j\omega\varepsilon\frac{\partial E_z}{\partial x} + \gamma\frac{\partial H_z}{\partial y}\right)$$

where symbols have their usual meaning. Then re-write the equation for attenuation free propagation. **(10+2)**

(b) For TE and TM waves derive the general equation for attenuation constant due to dielectric loss. **(8)**

(c) The transverse dimensions of an attenuation free rectangular waveguide are: a = 1.5 cm, b = 0.8 cm. Assuming μ_r = 1, ε_r = 4, and

$$H_x = 2\sin\left(\frac{\pi x}{a}\right)\cos\left(\frac{3\pi y}{y}\right)\sin\left(\pi\times10^{11}t - \beta z\right)A/m$$

Determine: **(15)**

(i) The mode of operation

(ii) The cutoff frequency

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Contd....Q. No. 5(c)

(iii) The phase constant, β

(iv) The propagation constant, γ

(v) The intrinsic wave impedance, η

6. (a) Derive the field equations for TM waves in perfectly conducting parallel plates. **(12)**

(b) For TM waves in perfectly conducting parallel plates prove that the attenuation constant due to conductor loss is given by, **(12)**

$a_c = \dfrac{2\omega\varepsilon R_s}{\beta d}$, where symbols have their usual meaning.

(c) Consider a length of air-filled copper X-band waveguide, with dimensions a = 2.286 cm, b = 1.016 cm. Find the cutoff frequency of the first four propagating modes. What is the attenuation in N_p/m of this guide when operating at 10 GHz frequency? Given, the surface resistivity of copper wall, $\sigma = 5.8 \times 10^7$ s/m. **(11)**

7. (a) Derive the equation for **H** fields at a distance r from a Hertzian dipole. Given that, in spherical coordinates *curl* of a vector A is, **(9)**

$$\nabla \times \bar{A} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial\theta}(A_{\phi s}\sin\theta) - \frac{\partial}{\partial\phi}(A_{\theta s})\right]\bar{a}_r + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial}{\partial\phi}(A_{rs}) - \frac{\partial}{\partial r}(rA_{\phi s})\right]\bar{a}_\theta$$
$$+\frac{1}{r}\left[\frac{\partial}{\partial r}(rA_{\theta s}) - \frac{\partial}{\partial\theta}(A_{rs})\right]\bar{a}_\phi$$

(b) Derive the Friis transmission formula. Then derive the radar transmission equation for a monostatic radar. **(8+8)**

(c) An S-band radar transmitting at 3 GHz radiates 200 kW. Determine the signal power density at a range 400 nautical miles if the effective area of the radar antenna is 9 m^2. With a 20 m^2 target at 300 nautical miles, calculate the power of the reflected signal at the radar. (1 nautical mile = 1852 m) **(10)**

8. (a) In case of free space propagation the field equation of a half-wave dipole is given by, **(15)**

$$\bar{H} = \frac{j}{2\pi r} I_0 e^{-j\beta r}\left[\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta}\right]\bar{a}_\phi ; \bar{E} = \frac{j}{2\pi r}\eta I_0 e^{-j\beta r}\left[\frac{\cos\left(\frac{\pi}{2}\cos\theta\right)}{\sin\theta}\right]\bar{a}_\theta$$

From these equations, show that $P_{rad}=36.56 I_0^2$; where symbols have their usual meaning.

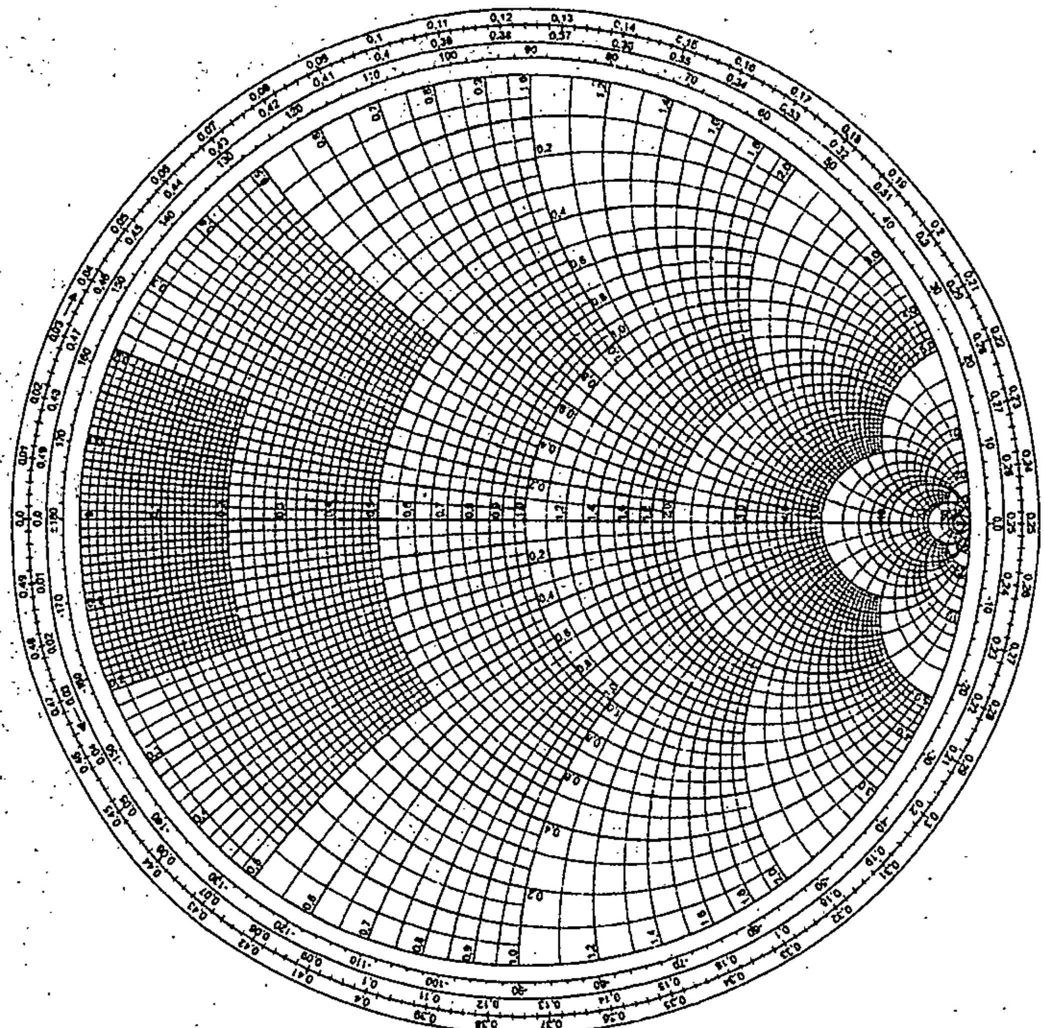
(b) What is quarter wave monopole antenna? Derive the expression of its radiation resistance. **(8)**

(c) The amplitude of the electric field intensity broadside to a half-wave dipole antenna at a distance of 15 km is 0.1 V/m in free space. If the operating frequency is 100 MHz, determine the length of the antenna and the total power that it radiates. Also, write the general expressions for the electric and magnetic field intensities in the time domain. **(12)**

EEE 433

Smith's Transmission Line Chart

(Please attach this chart with your answer script)



L-4/T-1/EEE **Date : 19/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **EEE 435** (Optical Communications)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) State and explain the merits of coherent detection over direct detection in an optical communication system. **(10)**

(b) Draw the block diagram of a coherent homodyne optical receiver and find the expression of the output photocurrent and signal-to-noise ratio. Compare the sensitivity improvement over a direct detection receiver. **(12.5)**

(c) What are the different types of optical couplers? Draw schematic of the followings: **(12.5)**

(i) 6-dB coupler (ii) (2×2) optical switch (iii) (4×4) optical switch (iv) star coupler

2. (a) What is Pockel's effect? Draw the schematic of a Electro-optic phase modulator (EOPM) and derive the expression of the modulated phase and the output optical PM signal. **(12.5)**

(b) Draw the schematic of a Mach-Zehnder Interferometer (MZI) and find its transmittance functions. Explain its operation as a WDM multiplexer and demultiplexer. **(12.5)**

(c) What is meant by MZM? Explain its operational principle with an schematic diagram. **(10)**

3. (a) Draw the block diagram of WDM transmission system with optical amplifiers in cascade. What are the purpose of OADM? State the limitations due to optical amplifiers. **(15)**

(b) A 100 km fiber optic link is operating at a wavelength of 1550 nm with a laser diode of FWHM linewidth of 2.5 nm and single mode fiber of material dispersion coefficient, D_M = 16 ps/km-nm. The loss coefficient of he fiber is 0.2 dB/km. The rise time of the transmitter is 10 ns and that of the receiver circuit is 15 ns. The receiver sensitivity is –90 dBm and loss-margin is 6 dB. Determine: **(20)**

(i) Minimum required power of the laser diode transmitter;

(ii) Overall system rise time and maximum allowable data rate through the link using NRZ data.

4. (a) Sate and explain the merits of optical amplifiers as compared to regenerative repeaters. **(10)**

(b)What are the different types of optical amplifies? Draw the schematic of an Erbium doped fiber amplifier (EDFA) and briefly explain its operational principle. Compare the gain

Contd P/2

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Contd ... Q. No.4

spectra of SoA and EDFA and comment on their suitability for applications in long-haul fiber-optic transmission. **(13)**

(c) Write short notes on (any Two): **(12)**

(i) Optical FDM (OFDM),
(ii) FBG bassed WDM MUX/DMUX,
(iii) Fiber Non-linear effects,
(iv) Arrayed Waveguide Grating (AWG).

SECTION – B

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

Symbols have their usual meanings.

5. (a) Define meridional ray and skew ray in optical fiber. For meridional rays, derive the expression relating to the numerical aperture and relative refractive index difference between core and cladding of an optical fiber. State the significance of this relationship. **(13)**

(b) Draw the attenuation spectrum of silica fiber and indicate different low loss windows suitable for optical fiber communication. **(8)**

(c) A step-index fiber has a core diameter of 8 μm and a core refractive index of 1.44. Estimate the range of wavelength of light for single-mode operation when relative index difference is 1.5%. It is required to increase the core diameter to 10 μm while maintaining the single mode operation at the same highest frequency. Estimate the maximum possible refractive index difference for the fiber. **(14)**

6. (a) Distinguish between intra-modal and inter-modal dispersion. Derive the expression of the rms pulse-width at the output of a single-mode fiber due to material dispersion. **(11)**

(b) Compare the dispersion characteristics of SMF, DSF, NZDSF, DFF and DCF. How dispersion compensation is carried out in a fiber optic link? **(10)**

(c) An MMF has a core index of 1.56 and cladding index of 1.52 at a wavelength of 1550 nm. The material dispersion coefficient is 16 ps/km-nm at this wavelength. The source is an LED with a relative spectral width σ_λ/λ of 0.0012 at this wavelength. Calculate, **(14)**

(i) the rms pulse width due to material dispersion at 1 km distance,
(ii) the rms pulse width due to intermodal dispersion at 1 km distance,
(iii) maximum achievable bit rate through 6 km fiber with return-to-zero coding.

7. (a) Define population inversion and write the Einstein relation for lasing action. **(10)**

(b) Draw the cross-section of an injection laser diode and derive the conditions for laser oscillations. **(12)**

Contd P/3

EEE 435

(c) Draw the typical input-output characteristics and spectral characteristics of an injection laser diode (ILD) and an LED. Comment on their applications in a fiber optic communication system using SMF and MMF. **(13)**

8. (a) Briefly explain the mechanism of photo detection in a PN photodiode. How are its limitations overcome in a PIN photodiode? **(10)**

(b) A digital optical fiber communication system operating at wavelength of $1 \mu m$ requires a maximum bit-error-rate of 10^{-9}. Determine: **(25)**

(i) the theoretical quantum limit (minimum pulse energy) at the receiver in terms of the quantum efficiency of the detector and the energy of an incident photon,

(ii) the minimum incident optical power required at the detector to achieve the above BER when the system is employing ideal binary signaling at 10 $Mbits^{-1}$. Assume the detector is ideal.

[Hint: Z_m = an average no. of photons detected in a time period of τ for a given BER;

$$Z_m = \frac{\eta P_0 \tau}{hf}]$$

L-4/T-1/EEE **Date : 02/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2017-2018

Sub : **EEE 351** (Analog Integrated Circuits and Design)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

All the symbols and notations used in these sections have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) MOS device capacitances (C_1 to C_6) are shown in the Fig. for Q. No. 1(a). Write down the expressions for all these capacitances in terms of various parameters of a MOSFET. Also draw a 3-D figure showing the decomposition of S/D junction capacitance into bottom-plate and sidewall components. **(15)**

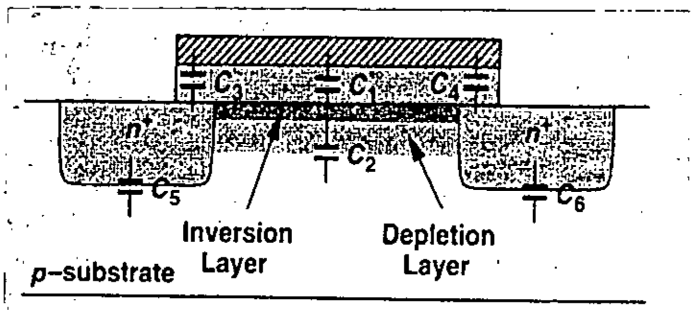

Fig. for Q. No. 1(a)

(b) For a *Common Source* (*CS*) amplifier with a drain resistor R_D and a *Source Degenerative* resistor R_S, the voltage gain is given by $A_v = -G_m R_D$. Determine the value of G_m. Hence determine the voltage gain of a *CS* stage amplifier (without source degeneration). **(10)**

(c) In reference to various stages of amplifiers, differentiate between the terms "*cascade*" and "*cascade*". Also draw the large-signal characteristics of folded cascode. **(10)**

2. (a) When a circuit can be called a *Switched-Capacitor Circuit*? Draw the general view of switched-capacitor amplifier and explain its operation in the sampling/amplifying modes. **(10)**

(b) On-resistances (not to scale) of 3 different sampling switches are shown in the Fig. for Q. No. 2(*b*). Identify which switch will perform better and why? **(10)**

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Contd ... Q. No. 2(b)

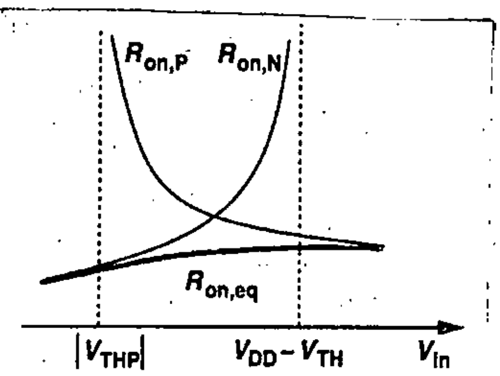

Fig. for Q. No. 2(b)

(c) Discuss the channel charge injection problem related to switched capacitor circuits. Define a figure of merit representing the speed of the switch by a time constant τ and the precision by the voltage error ΔV due to charge injection and prove that $\tau \Delta V = L^2/\mu_n$. **(15)**

3. (a) Differentially realize (i) a unity-gain sampler and (ii) a non-inverting amplifier with switched capacitors. **(8)**

(b) Design a parasitic-insensitive switched capacitor integrator and explain its operation in (*i*) sampling and (*ii*) integration modes. **(12)**

(c) Write short-notes on any 3 of the following: (i) Switched capacitor filters, (ii) Wilson current mirror, (iii) Eggshell analogy of IC design, (*iv*) Shot and burst noise in an electronic device. **(15)**

4. (a) Draw the linear and static characterization (circuit model) of a non-ideal CMOS Op-Amp. **(10)**

(b) Draw the classical two-stage CMOS Op-Amp and break it into voltage-to-current and current-to-voltage conversion stages. **(10)**

(c) What is PSRR of an Op-Amp? Draw the approximate models for $PSRR^+$ and $PSRR^-$ of a two-stage CMOS Op-Amp. **(15)**

SECTION – B

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

5. (a) Show that the small signal differential voltage gain of the circuit shown in Fig. for Q. No. 5(a) can be expanded as **(17)**

$$|A_v| = \sqrt{\mu_n C_{ox} \frac{W}{L} I_{ss}} R_D$$

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Contd ... Q. No. 5(a)

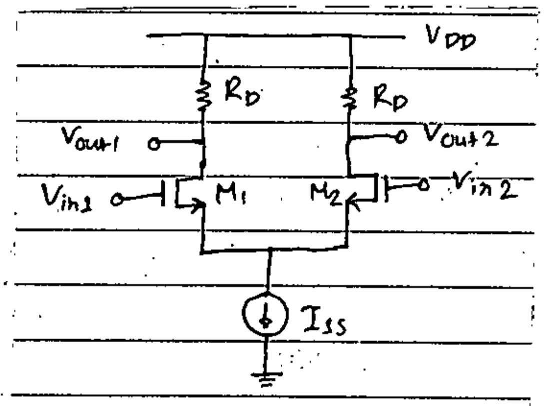

Fig. for Q. No. 5(a)

(b) In the circuit shown in Fig. for Q. 5(b), M_2 in twice as wide as M_1. Calculate the small-signal gain if the bias values of V_{in1} and V_{in2} are equal. Given that **(18)**

$\mu_n C_{ox} = 50\mu A/V^2$ and $\left(\frac{W}{L}\right)M_1 = 50$.

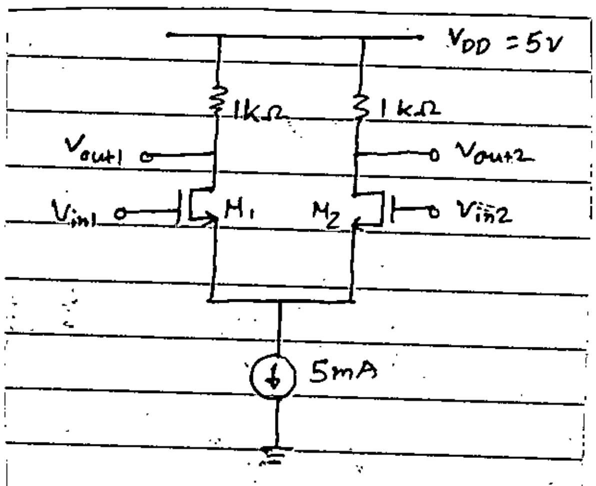

Fig. for Q. No. 5(b)

6. (a) The circuit shown in Fig. for Q. 6(a) is a cascode current mirror (i) Find the condition of MOS device dimensions for which $V_y = V_x$. (ii) Sketch V_x and V_y as a function of I_{REF} (iii) What is the maximum value of I_{REF}, if it requires 0.5 V to operate as a current source? Express in terms of supply voltage, MOS model parameters and dimensions. **(20)**

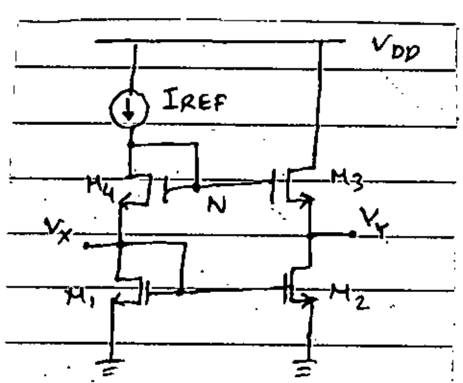

Fig. for Q. No. 6(a)

EEE 351

Contd ... Q. No. 6

(b) Calculate the small-signal voltage gain of the circuit shown in Fig. for Q. No. 6(b). **(15)**

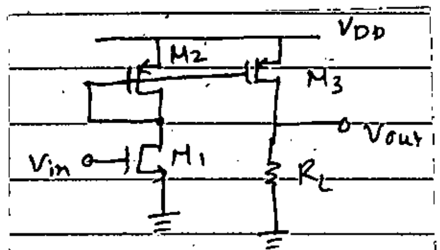

Fig. for Q. No. 6(b)

7. (a) What is the total output noise voltage of the common-source amplifier shown in Fig. for Q. No. &(a) **(15)**

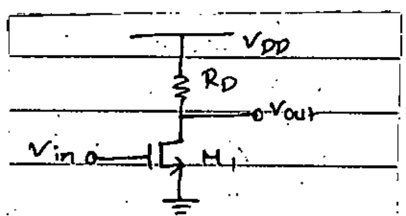

Fig. for Q. No. 7(a)

(b) Calculate the input-referred thermal noise voltage of the amplifier shown in Fig. for Q. No. 7(b), assuming that both the transistors are in saturation. Also, determine the total output thermal noise if the circuit drives a load capacitance C_L. What is the output signal-to-noise ratio if a low-frequency sinusoid of amplitude V_m is applied to the input? **(20)**

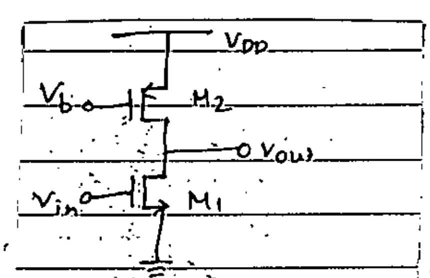

Fig. for Q. No. 7(b)

8. (a) Calculate ΔV_{BE} in the circuit shown in Fig. for Q. No. 8(a). Also, show that for this circuit temperature coefficient is independent of collector currents. **(15)**

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Contd ... Q. No. 8(a)

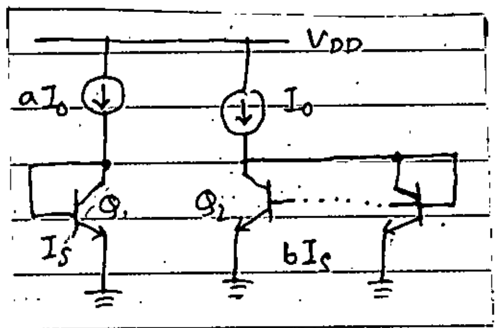

Fig. for Q. No. 8(a)

(b) Draw the circuit of a proportional to absolute temperature (PTAT) current generator which can be used to build a temperature independent reference voltage. Explain its operation. **(15)**

(c) Draw a circuit for constant-G_m biasing. **(5)**

L-4/T-1/EEE Date : 06/11/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **EEE 415** (Microprocessors and Embedded Systems)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

The symbols have their usual meanings.

SECTION – A

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

Datasheet for the ICs are given with the question.

The address pins are normally connected unless stated otherwise.

1. (a) Harold Finch is trying to make the 'Machine' on an 8086 based system. He has bought two **2KX8 RAMs** and **1KX8 ROMs** for this purpose. He wants to assign **18000H-18FFFH** space for RAMs and **19000H-1A7FFH** for ROMs. Furthermore, he wants to implement even-odd memory banking so that the 'Machine' can work efficiently. Design as address decoder for this set up and draw the connection diagram neatly. **(27)**

   (b) Write the code snippet for receiving a serial data in 8251A with base address of **FF00H**. You do not have to show initialization of 8251A here. **(8)**

2. (a) Nokla wants to return to mobile manufacturing business with their vintage 1110 set. The 4×3 keypad of this set is shown in <u>Fig. for Q. 2(a)</u>. As an engineer, you have to interface this keyboard in an 8086 based system by using 8255A with polling method and proper debouncing. The base address for the device is **FFF8H**. Answer the followings: **(25)**

   (i) Show the connection diagram of the keyboard and the 8255A. Mention which ports you are using as input.

   (ii) Draw the flowchart for the algorithm you will be using to interface the keyboard.

   (iii) Initiate the 8255A as per the design requirements. Write down the assembly code for the above mentioned system with brief and appropriate comments.

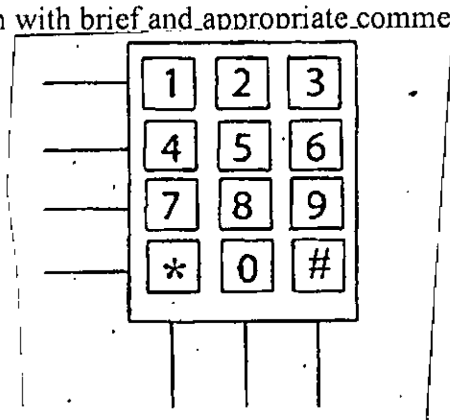

Fig. for Q. 2(a)

   (b) You have to design a real time clock (frequency 1 Hz) for the latest AMi Band 19 wristwatch. The clock frequency of the system is **1kHz**. You have to use 8254 IC for creating this real time clock. Mention which mode you will be using and why. Write down the assembly code for this system with brief and proper comments. **(10)**

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3. (a) Ironman and Captain America were fighting a robot army. They were having a competition of who can destroy 4000 robots first. They used the **counter 0** and **counter 1** of 8254 IC for this purpose in **mode 0**. After a while, Thanos arrived at the scene and wanted to destroy these two counters with a snap of his fingers. Before he destroyed those counters, Dr. Strange was able to latch the contents of both the counters and put the sum of the latched values in **counter 2** with **mode 0**. Answer the followings: **(21)**

    (i) By convention, the **A1** and **A0** pins of 8254 are connected to the **A2** and **A1** pins of the 8086. But here, the **A1** and **A0** pins of 8254 are connected to the **A7** and **A6** pins of the 8086. The address of **counter 0** is **1234H**. Find the address of **counter 1, counter 2** and **control register**.

    (ii) Write down the assembly code for this system. Initialize all the counters properly. Provide brief and appropriate comments with the code.

   (b) Write the initialization sequence in assembly language for an 8251 A (Base address: **FF00H**) considering: baud rate factor of 64, 7 bits/character, even parity, 1 stop bit, transmit and receive interrupts enabled, DTR and RTS asserted and error flag reset. **(14)**

4. (a) In an 8086 microprocessor based system two 8259A priority interrupt controller ICs are configured as master and slave. The INTR of slave is routed through **IR7** of the master 8259A to the 8086. Let the slave be interrupted at **IR5**. The interrupt type of **IR7** of master is **47H** and **IR5** of the slave is **65H**. The internal addresses of master are **B8H** and **BAH** while the internal addresses of slave are **138HH** and **13AH**. **(30)**

    (i) Draw the schematic of the system neatly with proper address decoding.

    (ii) Does the slave 8259A directly send the interrupt to 8086? If not, then how does the 8086 receive the interrupt of slave 8259A? How does both the master and the slave 8259A receive the interrupt acknowledgement from the 8086?

    (iii) Write assembly language codes to initialize both master and slave considering the following facts:

    (*a*) Master and slave are both level triggered.

    (*b*) Buffers are not used.

   (b) The following table contains the conditions of memory banking. Complete the table in your answer script. Add any extra line if necessary. **(5)**

Function	$\overline{BHE}$	A_0	Number of Bus Cycles
Reading/ Writing Byte from Even Address			
Reading/ Writing Word from Even Address			
Reading/ Writing Byte from Odd Address			
Reading/ Writing Word from Odd Address			

Datasheets:

8255A Mode Set Control Word

D7	D6	D5	D4	D3	D2	D1	D0
Mode Set Flag	Port A Mode		Port A I/O	Port C (U) I/O	Port B Mode	Port B I/O	Port C (L) I/O

8251 Mode Instruction (Asynchronous Mode)

D7	D6	D5	D4	D3	D2	D1	D0
S2	S1	ep	pen	L2	L1	B2	B1

8251 Command Word

D7	D6	D5	D4	D3	D2	D1	D0
EH	IR	RTS	ER	SBRK	RxE	DTR	TxEN

8251 Status Word

D7	D6	D5	D4	D3	D2	D1	D0
DSR	SYNDET	FE	OE	PE	TxE	RxRDY	TxRDY

8254 Control Word

D7	D6	D5	D4	D3	D2	D1	D0
SC1	SC0	RW1	RW0	M2	M1	M0	BCD

8259 PIC Control Words

	A0	D7	D6	D5	D4	D3	D2	D1	D0
ICW1	0	A7	A6	A5	1	LTIM	ADI	SNGL	IC4
ICW2	1	A15/T7	A14/T6	A13/T5	A12/T4	A11/T3	A10	A9	A8
ICW3 Master	1	S7	S6	S5	S4	S3	S2	S1	S0
IC3 Slave	1	0	0	0	0	0	ID2	ID1	ID0
ICW4	1	0	0	0	SFNM	BUF	M/S	AEOI	µPM
OCW1	1	M7	M6	M5	M4	M3	M2	M1	M0
OCW2	0	R	SL	EOI	0	0	L2	L1	L0
OCW3	0	0	ESMM	SMM	0	1	P	RR	RIS

SECTION – B

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

5. (a) Suppose, your class teacher has saved the marks of four class tests in an array as shown below:

```
; comment:          CT1   CT2   CT3   CT4
MARKS        DW     10    12    18    15     ; student1
             DW     18    14    20    10     ; student2
             DW     15    16    12    11     ; student3
             DW     8     20    20    15     ; student4
N            DW     4                        ; total no. of students
```

You have to write a code to help him to find out the final marks by taking the best three out of four class test marks. **First**, explain your **work flow**. **Then** write the assembly code. Save the output in an array named FINAL. You do not have to copy the given code snippet in your exam script. **(18)**

(b) Explain how directional flag controls the string operations in an 8086 assembly code. Use REPE and CMPSB commands in an assembly code to determine whether two strings STR1 and STR2 are palindrome. String lengths are unknown and can be unequal. After the execution of your program, AX will be 1 if palindrome and 0 otherwise. **(17)**

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6. (a) The following statements are part of a continuous code. Write the values of the status flags (ZF, SF, PF, OF, CF) after sequential execution of each instruction, Initially, AX =0FFFFH, BX = 8000H, CX = 0002H and DX = OFFFFH. **(15)**

```
i.    ADD AX,BX
ii.   DEC BX
iii.  SUB BX,DX
iv.   NEG BX
v.    INC BX
vi.   RCR BX
vii.  SAR BX,CL
```

(b) The address 7500:BFD2h has an instruction. To execute the instruction, what should be the value of CS if IP is- **(10)**

(i) AB22h (ii) BFDAh

What is the advantage of the overlapping nature of memory segment?

(c) Compare the salient features of assembly language to that of a high-level language. **(4)**

(d) The following code snippet stores the sun of natural numbers upto the value of CX in AX.

```
MOV AX,0
L1: ADD AX,CX
LOOP L1
```

What happens if CX=0? Rewrite the code keeping this possibility in mind. **(6)**

7. (a) Determine the value of AX after execution of the following code. What is the purpose of this code? Write a more efficient code to replace this one. **(17)**

```
CODE SEGMENT
        ASSUME CS: CODE, DS: CODE
        MOV AX, CS
        MOV DS, AX

        MOV BX, 0
        MOV AX, 1
        MOV CX, 6
L1:     ADD AX, BX
        JMP L2
L3:     LOOP L1
        HLT

L2:     ADD AX, BX
        NEG BX
        ADD BX, AX
        SUB AX, BX
        JMP L3
```

(b) For each of the following statements state the addressing modes of the source and destination operands. **(10)**

```
i.    MOV BX, 1000H
ii.   MOV ALPHA, AX        ; where ALPHA is a word variable
iii.  ADD CX, -2[BX]
iv.   MOV [BX]+ALPHA, CX
```

EEE 415

(c) Answer the following short questions- **(8)**

(i) Why is it important to latch the contents of 8086 address bus?

(ii) What are the differences between the 'near' and 'far' procedures in 8086?

(iii) What is the significance of overflow in IMUL command?

(iv) What is the difference between SHR and SAR command?

8. (a) An 8086 system has four 4Kx8 ROMs (address starting from 1F800H), four 2K×8 RAMs (address starting from right after the last address of the ROMs) and one 8255 PPI (base address 7800). Design an address decoder for this system using 74138 IC (3-to-8 decoders) and/or logic gates. Provide the memory map and a neat connection diagram with proper labeling. **(18)**

(b) Consider a standard SAP-1 system. Write down what happens in the T cycles of an LDA operation as briefly as possible. **(5)**

(c) Hand-assemble the program of Fig. for Q. N. 8(c)(i), written for a standard SAP-2 system. The program starts from 2000 H address. The opcodes of necessary operations are given in Fig. for Q. No. 8(c)(ii).

Code
NOP
MVI A, 20 H
MVI B, 30 H
INR A
JMP [2010 H]
ADD B
MOV C, A
STA [6000 H]
HLT

Fig. for Q. No. 8(c)(i)

Instruction	Op code
ADD B	80 H
INR A	3C H
HLT	76 H
MVI A, byte	3E H
MVI B, byte	06 H
MOV C, A	4F H
NOP	00 H
STA address	32 H
JMP address	C3 H

Fig. for Q. No. 8(c)(ii)

What is the value of the program counter after the code terminates? Determine the values of the registers A, B and C after the execution of the code. **(12)**

L-4/T-1/ARCH **Date : 24/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Arch. Examinations 2018-2019

Sub : **ARCH 461** (Survey and Research Methods)

Full Marks : 140 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. Evaluate different stages of a scientific research. **($23\frac{1}{3}$)**

2. What are the attributes of a questionnaire? How to design a questionnaire? **($10+13\frac{1}{3}$)**

3. How to do research interviews? What are the stages of an interview investigation? Write down the types of interview questions with examples. **($5+5+13\frac{1}{3}$)**

4. What is a literature review? How to assess the literature and structure the literature review. **($5+18\frac{1}{3}$)**

SECTION – B

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

5. What are primary and secondary data? Explain different sources for primary and secondary data collection? Define different types of variables used in statistics. **($23\frac{1}{3}$)**

6. Distinguish between population, sample and sampling unit. Critically evaluate various methods for sample selection process under probability and non-probability sampling with examples. **($23\frac{1}{3}$)**

7. What is a scientific report? Describe the stages involved in writing a report with checklist. **($23\frac{1}{3}$)**

8. Differentiate between mean, median and mode. In a survey, it was found that in the same apartment building the electricity bills of 2, 4 and 6 members (X value) families are 2000, 3000 and 4000 (Y value) taka. Draw a regression line and write the equation of the line to predict the electricity bill of a family with 3 members in the same apartment building. **($23\frac{1}{3}$)**

L-4/T-1/EEE Date : 24/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1. B. Sc. Engineering Examinations 2018-2019

Sub : **EEE 463** (Nano-electronics and Nanotechnology)

Full Marks : 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Show that, $G_B = \frac{q^2 D_v}{2L}\left\{1, \frac{2}{\pi}, \frac{1}{2}\right\}$, where symbols have their usual meaning. **(22)**

(b) Derive the thermal broadening function. Why it is important for current flow? **(5+8)**

2. (a) Discuss the obstacles in miniaturization of microelectronic devices. **(15)**

(b) How does a nano-sized "island" can function in resonant tunneling devices? Explain with proper energy diagrams. **(20)**

3. (a) What is a Coulomb blockade? How does this concept explain the operation of SET device? **(17)**

(b) Give some examples of molecular conductors that could be used as functional groups in molecular scale switches. **(10)**

(c) What is an elastic resistor? **(8)**

4. Write short notes on the following topics (any 4): **(35)**

(a) Dip Pen lighograpy, (b) Micro-contact printing, (c) PDMS, (d) Langmuir-Blodgett methodology, (e) Casimir effect.

SECTION – B

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

5. (a) What is resolution in microscopy? How does it improve in electron microscopy? **(15)**

(b) Discuss, with neat diagrams, how an STM works. **(20)**

6. (a) For single molecule manipulation, how does a laser tweezer compare with cantilevers (as in AFM)? What surface actions are important for bottom-up processes? **(10+10)**

(b) Explain some potentials for self-assembled monolayers. **(15)**

Contd P/2

7. (a) What are the chief drawbacks of dry etching and wet etching techniques? What are the applications of oxide layer? **(15)**

   (b) How does an MBE growth different than MOCVD growth? Explain, in detail, with proper diagrams. **(20)**

8. (a) What are the pros and cons of positive and negative photoresists? What are the major contamination sources in a clean room? **(20)**

   (b) What is wetting process? Define the spreading coefficient. What does s>0 signify, in this respect? **(15)**

L-4/T-1/EEE **Date : 29/10/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

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) "The CT ratio for all the CTs in the busbar differential scheme has to be same and is decided by the feeder carrying maximum current." – Explain. **(7)**

(b) Why does a busbar differential scheme has tendency to operate for external faults? **(8)**

(c) A 132 kV busber consists of two incoming and four outgoing lines. The parameters are: **(4×5=20)**

Maximum full load current in one line : 500 A

CT secondary resistance = 0.7 Ω

R_{lead} wire = 2.0 Ω

Relay load (1 A relay is used) = 1.0 Ω

CT magnetizing current up to 120 V = 0.28 mA/V

CT saturation voltage V_{knee} > 120 V

Rstab = 94.93 Ω

(i) If the pickup value of the relay is 0.861A, Find the minimum internal fault current.

(ii) Find Vset

(iii) Find the switchgear capacity in MVA.

(iv) It is required that a break in the pilot wire from a CT carrying current of 25 A and more should be detected by supervisory relay. Calculate setting of supervisory relay.

2. (a) Explain why over-current protection scheme cannot be used in Extra high voltage lines. **(10)**

(b) Consider a portion of 138 kV Transmission system as shown in Fig. 2(b). Lines 1-2, 2-3, 2-4 are respectively 64, 64 and 96 km long. The positive sequence impedance is 0.05+j0.5 Ω per km. The maximum load carried by line 1-2 under emergency conditions is 50 MVA. Design a three zone step distance relaying system to the extent of determining for R_{12} the zone settings which are the impedance values in term of CT and CVT secondary quantities. (i) Draw the characteristics of a corresponding directional impedance relay and mho relay in the RX plane. Mention which circuit breaker will trip first when fault occurs at P_2. Why? **(18+2=20)**

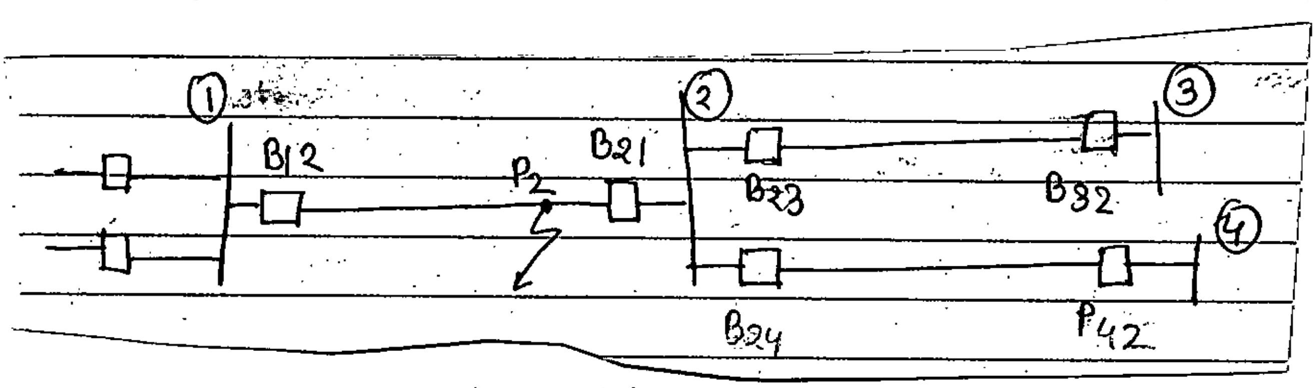

Fig. 2(b)

Contd P/2

<u>**EEE 477**</u>

(c) Explain the effect of Arc resistance on the reach of simple impedance relay. **(5)**

3. (a) What are the drawbacks of using DTOC relays for the protection of long feeders, if graded time lag scheme is used? **(10)**

(b) What are the situations where DTOC relays are preferred over IDMT relays? **(5)**

(c) Consider a radial feeder with buses A, B and C where IDMT relays are to be used as shown in Fig. 3(c). **(4×5=20)**

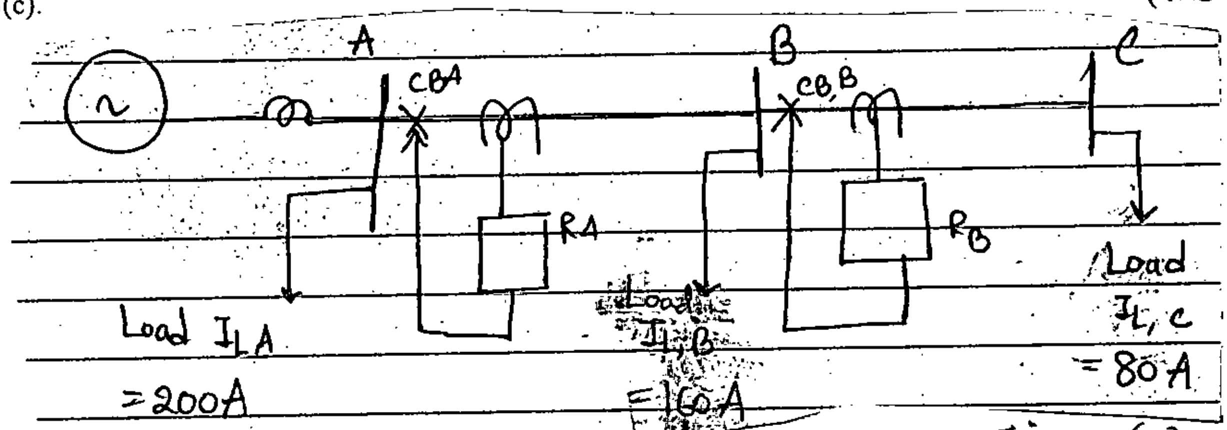

Fig. 3(c)

Bus A	Bus B	Bus C
I_{fl} min = 3500 A	I_{fl} min = 2000 A	I_{fl} min = 1000 A
I_{fl} max = 4000 A	I_{fl} max = 3000 A	I_{fl} max = 1500 A

(i) Assume that overload margin is 25%, and a 5 A relay is used. Find the plug setting of R_A and R_B. (Assume any CT ratio for your convenience)

(ii) If the TMS of R_B is 0.1, find the operating time of R_B for maximum fault at B.

(iii) Assuming overshoot time of R_A is 10% find required operating time of R_A for maximum fault at Bus B.

(iv) What is the TMS of R_A.

4. (a) Using universal torque equation, derive the trip law for reactance relay used for transmission line protection. **(10)**

(b) Describe how actuating force is produced in induction-type relays. **(10)**

(c) What are the different types of actuating structures of induction type relays? Briefly describe any two. **(15)**

<u>SECTION – B</u>

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

5. (a) Explain the various methods of arc extinction in a circuit breaker. **(13)**

(b) With necessary sketches explain resistance switching in an air blast circuit breaker. **(12)**

(c) Explain the operating principle of a vacuum circuit breaker. **(10)**

6. (a) Explain the use of isolator and earthing switch. **(8)**

(b) What is the effect of CT saturation on over current protection? **(7)**

(c) Draw the single-line diagrams of the bus-bar systems: (i) duplicate bus-bar arrangement, and (ii) one and a half breaker arrangement. **(10)**

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(d) In a system the rms voltage is 19.1 kV, L is 10 mH and C is 0.02 μF. Determine the average rate of rise of restriking voltage when the circuit breaker opens. **(10)**

7. (a) Prove that the slope of the internal fault characteristics of the percentage differential relay for a single-end-fed system is 200% **(8)**

(b) Describe the transverse differential protection of generator winding for inter-turn fault. **(12)**

(c) With necessary equations explain the inrush phenomenon of a transformer. What are the factors on which the magnitude of inrush current depends? **(15)**

8. (a) Explain the principle of operation and installation guidelines of the Buchholz relay. **(12)**

(b) Why is over-fluxing harmful for the transformer? What is the principle of over-fluxing protection? **(12)**

(c) What are the consequences of running an induction motor on unbalanced supply voltage? **(6)**

(d) How does HRC fuse operate? **(5)**

L-4/T-1/EEE Date : 29/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **EEE 453** (VLSI Circuits and Design I)

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) Using a structured design approach, develop a bus arbitration logic for n-line bus such that access is given to the highest priority line. If prioriry is given according to ascending order (line n highest priority), draw the schematic diagram and the stick diagram of the basic cell. **(18)**

(b) Show the transistor level implementation of the following logic functions in a CMOS NOR-NOR programmable logic array (PLA): **(17)**

$$z_1 = \bar{a}b + c\bar{d}$$
$$z_2 = ab + c\bar{d}$$
$$z_3 = cd$$

2. (a) A sequenc detector produces a '1' for each occurrence of the input sequence '0101' at its input. Draw the state transition diagram of the Finite State Machine (FSM) realizing the sequence detector. Obtain the state table and state assigned table from the state transition diagram. Realize the FSM using D flip flops and combinational logic. **(20)**

(b) Write the verilog code for synthesizing the sequence detector in Question 2(a). **(15)**

3. (a) Draw the circuit diagram of a 2×2 bit six transistor static random access memory (SRAM) array. Show clearly the row select, column select, pre-charge, sense amplifier and I/O signal lines. Explain how 'READ' operation is performed for this array. **(17)**

(b) Explain, with appropriate figure, how the capacitance of a one transistor dynamic memory cell can be increased. **(9)**

(c) With a neat diagram, show clearly how two phase clock can be generated using D flip-flops and combinational logic building blocks. **(9)**

4. (a) A 4-bit datapath consists of register, ALU and a shifter. Show two possible bus architectures of the system such that an addition operation of two operands stored in the register and storing the result back in the register can be computed in at most 2 clock cycles. **(16)**

(b) Draw the schematic diagram of a bidirectional I/O port at MOS transistor level with optimum number of transistors. Explain how noise can be filtered with the help of Schmitt Trigger. **(6+5)**

Contd P/2

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Contd. ... Q. No. 4

(c) In the figure for Q. 4(c), transistor 2 is stuck open (O_1) as shown. Write all the two pattern test vectors that will detect the fault. **(8)**

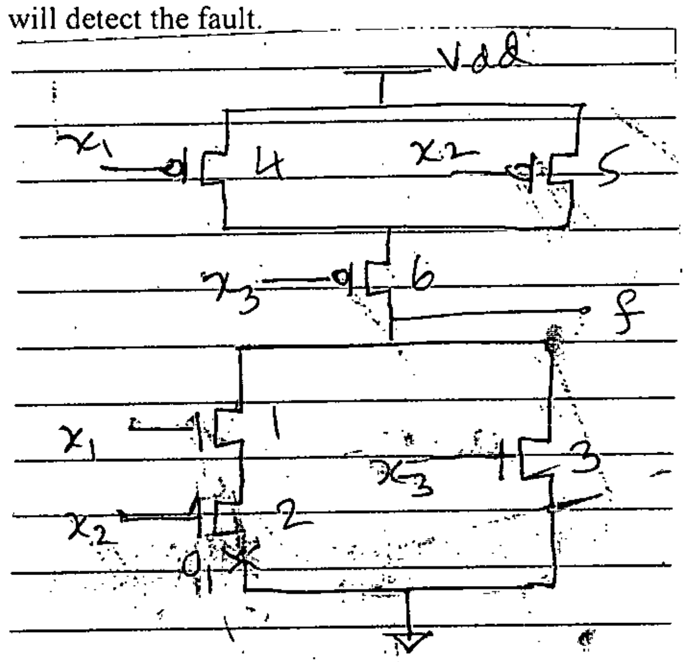

Fig. for Q 4(c)

SECTION – B

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

5. (a) With necessary figures, explain what happens to the transfer characteristics curve and noise margins NM_L and NM_H when B_P/B_N is decreased in a CMOS inverter pair. Assume that the logic levels are selected at the unity gain points of the DC transfer characteristics curve to maximize the noise margin. **(17)**

(b) Calculate the output voltages V_{out1}, V_{out2} and V_{out3} in Fig. for Q. 5(b). Assume V_{to} =1V, $\gamma = 0.5\ V^{1/2}$ and that the initial voltage at all the above nodes were zero. **(18)**

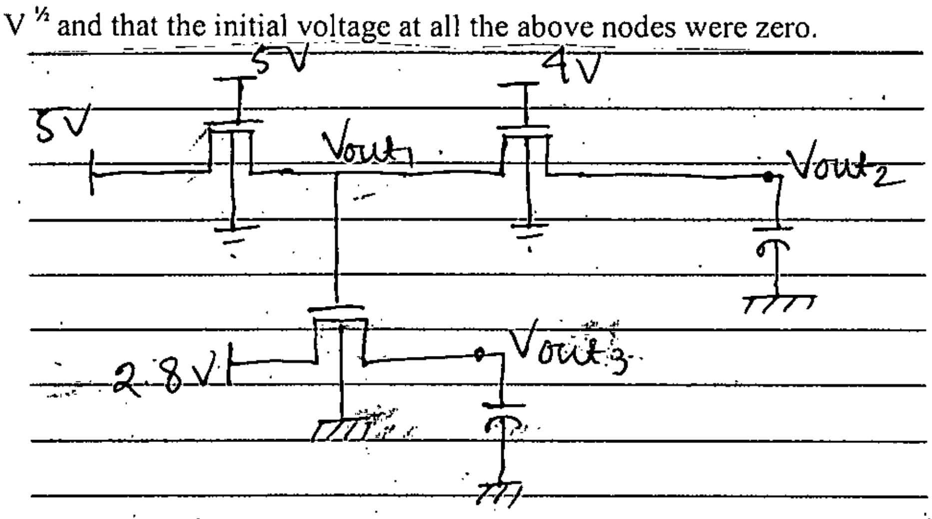

Fig. For. Q. 5(b)

6. (a) A 4-input OR gate is built with 2 two-input NOR gates and 1 two-input NAND gate. The outputs of the NOR gates are connected to the inputs of the two-input NAND gate. The data is completely random. Find the activity factor at the output node. Also, find the dynamic power dissipated in the gate, if the clock frequency is 2 GHz, the supply voltage is 1.2 V and the load capacitance is 5 pF. **(16)**

(b) Explain with necessary figure how clock gating can be used to reduce dynamic power. **(9)**

(c) Explain with necessary figures how sleep transistors can be used to reduce static power consumption. How can invalid logic levels be prevented from propagating to next block? What should be the size of the sleep transistors? **(10)**

7. (a) A buffer chain circuit is to be designed for a clock signal which will drive 1000 logic gates. The input capacitance of each of the logic gates is 12 fF and the output capacitance is 4 fF. The minimum sized inverter in the process has an input capacitance of 3 fF and the output capacitance is also 3 fF. Find the size (n) and the number of stages (m) of the required buffer chain. You have to derive any equations used in your calculations. **(17)**

   (b) Consider the CMOS implementation of the logic $F = \overline{(A+B)\cdot C}$ **(18)**

   (i) Sketch a transistor level schematic diagram suitable for drawing in the stick diagram.

   (ii) Sketch a stick diagram corresponding to the schematic diagram.

   (iii) Estimate the minimum area from the stick diagram by counting the number of wiring tracks.

8. (a) Show in diagram the origin and model of CMOS latch up in a PWELL process. How can lacth up be prevented? **(15)**

   (b) Sketch a 3-input NOR gate with transistor widths chosen to achieve worst case rise and fall resistance equal to a unit inverter. Let C and R be the gate/diffusion capacitance and resistance respectively of a unit NMOS transistor ($W_n = W_{min}$, $L_n = L_p = l_{min}$). Assume $\mu_n = 2\mu_p$ and that standard layout practice was followed. Assume that for merged uncontacted diffusion, the output capacitance is ½ C and for shared contacted diffusion, the output capacitance reduced by 1 C. **(20)**

   (i) Show the layout of the above NOR gate.

   (ii) Sketch the transistor level schematic of the gate. In the schematic back annotate the capacitance at each node of the circuit as calculated from the layout.

   (iii) If C = 1 fF/μm and R = 1.25 kΩ.μm in 65 nm process, determine propagation delay (t_{pd}) and contamination delay (t_{cd}) of the above NOR gate having fan out of 4 similar NOR gates.

L-4/T-1/EEE Date : 19/10/2019

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **EEE 455** (Compound Semiconductor Devices)

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 meaning. Make necessary assumptions.

1. (a) Draw E–k diagram of Si and GaAs semiconductors and compare carrier (electron and hole) mobility in these semiconductors from E–k diagram. Why does some semiconductors show negative differential mobility? Define optical phonon. **(20)**

   (b) Evaluate critical thickness of GaAs epitaxial layer on Si and InP substrates. How does critical thickness play important role in epitaxial layer growth of compound semiconductors? [Given: $a_{Si} = 5.43\text{Å}$, $a_{GaAs} = 5.65\text{Å}$, $a_{InP} = 5.87\text{Å}$] **(15)**

2. (a) Differentiate between the heavy-hole and light-hole states. With neat diagram, explain the hole band dispersions of GaAs on Si and InP substrates. What is Vegard's law? **(20)**

   (b) What is conductivity modulation? How does this conduction mechanison contribute to performance improvement in electronic devices? Explain, with neat diagrams, the advantages of superlattice structure. **(15)**

3. (a)d Design an HBT structure for high speed application and explain with necessary energy band diagrams. Why conduction band sometimes termed as 'a launching pad' for ballistic electrons in HBT? **(20)**

   (b) Draw detailed energy-band diagram of a metal-semiconductor junction with an interfacial layer and interface states in thermal equilibrium. Show, how the Fermi level becomes 'pinned'? **(15)**

4. (a) Draw the I-V characteristics of a resonant-tunneling diode and explain why the characteristic are different to that of conventional tunnel diode. **(20)**

   (b) Draw structure of resorant-tunneling diode using GaAs/AlGaAs heterostructure. With neat diagrams, explain transmission coefficient of electron with energy E through a double barrier via coherent resonant tunneling. **(15)**

Contd P/2

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SECTION – B

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

(i) All the symbols have their usual meanings.

(ii)Assume reasonable values for missing data

5. (a) Consider n-type Ge doped with $N_d = 10^{16}/cm^3$ and p-type GaAs doped with $N_a = 10^{16}/cm^3$. Let $T = 300$ K so that $n_i = 2.4\times10^{13}/cm^3$ for Ge. Determine ΔE_c, ΔE_v, and V_{bi} for an n-Ge to P-GaAs hetorojunction. The electron affinities of Ge and GaAs are 4.13 eV and 4.07 eV, respectively. **(15)**

(b) Explain four basic types of heterojuncitons showing their ideal energy-band diagrams in thermal equilibrium. **(20)**

6. (a) Consider a uniformly doped silicon bipolar transistor at $T = 300$ K with a base doping of $N_B = 5\times10^{16}/cm^3$ and a collector doping on $N_C = 2\times10^{15}/cm^3$. The neutral base width changes from 0.648 μm to 0.597 μm as the V_{CB} changes from 2V to 10V. Calculate the change in collector current and estimate the Early voltage. Assume $D_B = 25$ cm^2/s, $V_{BE} =$ 0.6 V and $x_B << L_B$. **(20)**

(b) Consider a silicon emitter at $T = 300$ K. Assume the emitter doping increases from $10^{18}/cm^3$ to $10^{19}/cm^3$. At these doping levels, the bandgap-narrowing factor changes from 30 meV to 100 meV. Determine the increase in p_{E0} in the emitter due to bandgap-narrowing. **(15)**

7. (a) The Schottky barrier height of a metal-n-GaAs MESFET is 0.9 V. The channel doping is $N_d = 1.5 \times 10^{16}/cm^3$, the channel thickness is $a = 0.5$ μm, and $T = 300$ K. Calculate the internal pinchoff voltage V_{p0} and the threashold voltage V_T. Determine whether the MESFET is depletion type or enhancement type. **(15)**

(b) Two n-channel GaAs MESFETs have barrier heights of 0.89 V. The channel doping concentration in device 1 is $N_d = 3 \times 10^{16}/cm^3$ and that in device 2 is $N_d = 3 \times 10^{17}/cm^3$. Determine the channel thickness required in each device such that the threshold voltage is zero for each device. **(20)**

8. (a) Consider an N-$Al_{0.3}Ga_{0.7}$As–intrinsic GaAs abrupt heterojunction. Assume that the AlGaAs is doped to $N_d = 3 \times 10^{18}/cm^3$ and has a thickness of 350Å. Let $\varphi_{Bn} = 0.89$ V, and assume that $\Delta E_c = 0.24$ eV. Calculate V_{off} and n_s for $V_g = 0$. **(20)**

(b) Consider an abrupt N-$Al_{0.3}Ga_{0.7}$As-intrinsic GaAs heterojunction. The N-AlGaAs is doped to $N_d = 2 \times 10^{18}/cm^3$. The Schottky barrier height is 0.85 V and the heterojunction conduction-band edge discontinuity is $\Delta E_c = 0.22$ eV. Determine the thickness of the AlGaAs layer so that $V_{off} = -0.3$ V. **(15)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

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

Full Marks: 210   Time: 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

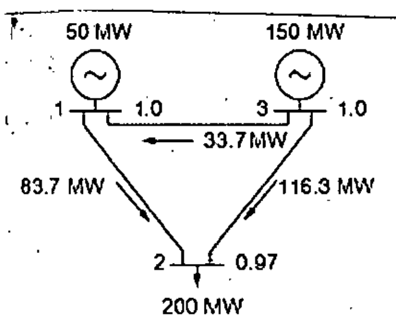
All the symbols have their usual meanings. Assume practical value for any missing data.

SECTION – A

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

1. (a) Discuss the differences between reliability, security and resilience. **(15)**

(b) Explain if the following system is secure. What to be done to make it secure in case it is not secure. Determine the production costs in both cases. Suppose bus voltages remain always with the limit of 0.95 to 1.05 pu. **(12)**



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

Generator (Bus)	Cost $/h	P_G^{max} MW	P_G^{min} MW
1	$100 + 20P_G$	200	50
3	$200 + 10P_G$	200	50

Fig. for Q. 1 (b)

(c) Discuss the differences between preventive and corrective control. **(8)**

2. (a) For a 5-bus and 6-line power system the S_f matrix and order relevant information are given below. It has two loads at buses 1 and 2 while three generators at buses 3, 4, 5. Each line can carry a maximum of 1000 MW. The generator at bus 5 is the slack generator.

$$S_f = \begin{bmatrix} 0.4828 & -0.3448 & 0.4138 & 0.3448 \\ 0.1034 & 0.0689 & -0.4828 & -0.0689 \\ 0.4138 & 0.2759 & 0.0689 & -0.2759 \\ 0.4828 & 0.6552 & 0.4138 & 0.3448 \\ 0.1034 & 0.0689 & 0.5172 & -0.0689 \\ 0.5172 & 0.3448 & 0.5862 & 0.6552 \end{bmatrix}$$

Line i, j
L1 1-2
L2 1-3
L3 1-4
L4 2-5
L5 3-4
L6 4-5

Node	P_L MW	Q_L Mvar	P_G MW
1	1500	750	—
2	500	250	—
3	0	0	1000
4	0	0	750
5	0	0	309

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Contd. Q. ... No. 2(a)

Determine the ranking indices (RI) for three contingencies (in N-1 condition) respectively outage of G3, L3 and L4. Suppose generator outage is compensated only by the slack generator. Using the RI values interpret if any masking effect is there. **(27)**

(b) Discus two other methods for contingency screening. **(8)**

3. (a) In a 5-bus and 6-line system bus 5 generator is the slack. In base case the loads at buses 1 and 2 are respectively 1500 and 500 MW while the generation at buses 3 and 4 are respectively 1000 MW and 750 MW. Each line flow limit is 1000 MW while each generator's maximum and minimum limits are 1500 MW and 250 MW, respectively. Each line has a reactance of 0.02 pu excepting 1st and 3rd lines which has 0.01 pu reactance each, all on 100 MVA base.

   Using a DC OPF model develop the framework for correcting overload applying preventive (pre-contingency) and corrective (post-contingency) generation adjustments and post contingency load shed in case line 2 trips. The B matrix respectively with and without the tripped line (B_p and B_c) and the line information are given below. **(22)**

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

Line	i, j
L1	1-2
L2	1-3
L3	1-4
L4	2-5
L5	3-4
L6	4-5

(b) What are the actions that are usually taken in a power system in case (i) frequency decreases gradually, (ii) frequency decreases abruptly? Explain. **(8)**

(c) In a smart grid what can be done for the problems mentioned in (a) above? Explain. **(5)**

4. (a) Explain the significance of social welfare in electricity market. **(5)**

   (b) Explain the differences between MCP and LMP. **(5)**

   (c) How can a smart grid help an individual consumer in electricity market? **(5)**

   (d) Suppose the ISO has received at 11 am the following offers and bids respectively from 3 GenCos and 2 DisCos in the on-line auction process for the spot market operation at 12 noon of the same day.

Table for Q. 4(d)

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	8	9	10		Price $/MWh	20	15	7	5	18	16	11	5

Contd P/3

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Contd. Q. ... No. 4(d)

There is no constraint on the capacity of transmission lines, minimum output and ramping rate of the generation units. Using a graph paper determine the probable 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. Attach the graph paper with your script. **(20)**

SECTION – B

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

5. (a) What is an EMS? Draw the basic model of an EMS showing its main components. **(5)**

(b) With a functional diagram, explain the working principle of a PMU. **(10)**

(c) What are the states of a power system from security point of view? What are the three functions of power system security control scheme? **(5)**

(d) Establish the following relationship for a synchronous generation in terms of frequency control. $\Delta P_{mech} - \Delta P_{elec} = Ms\Delta\omega$ **(15)**

6. (a) Why is state estimation necessary? What is the difference between load flow and state estimation? **(10)**

(b) In the dc 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. The measurement weights are: w_1 = 100, w_2 = 100 , w_3 = 50, and w_4 = 50. Determine the weighted least squares estimates of V_1 and V_2. **(25)**

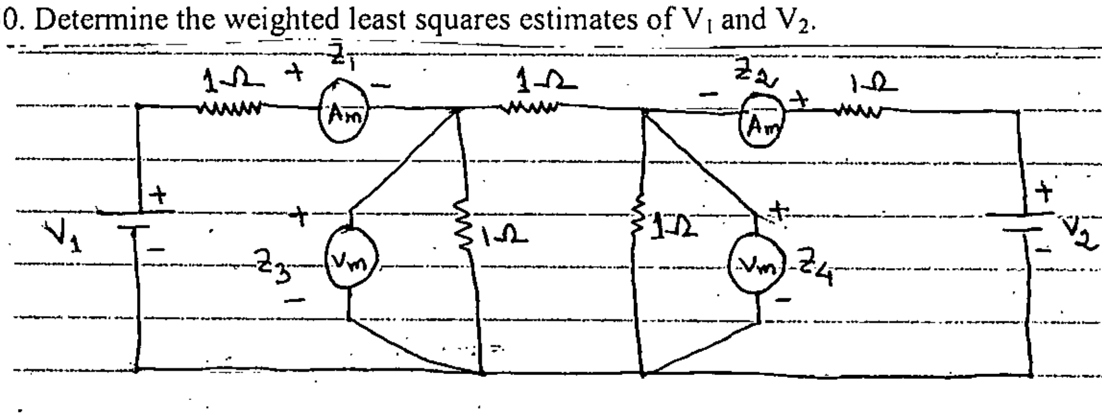

Fig. for Q. 6(b)

7. (a) The incremental fuel cost in ($/MWhr) for a plant consisting of two units are given by: $\lambda_1 = (0.008\ Pg_1 + 8)$ and $\lambda_2 = (0.0096\ Pg_2 + 6.4)$. The maximum and minimum generation capacities of both units are 625 MW and 100 MW, respectively. Determine the annual saving in fuel cost (in $) for the economic distribution of a total load of 900 MW between units compared to the equal distribution of the same total load. **(15)**

(b) How can the multistage decision making process of a unit commitment problem be dimensionally reduced? **(5)**

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Contd. Q. ... No. 7

(c) The daily load curve of a power system has three stages as follows. Stage-1: 1800 MW, Stage-2: 1400 MW and Stage-3: 1100 MW. System load is met by four generators. The start-up cost of each generator is \$3000 and the shutdown cost is \$1500. The possible combinations of generators are shown in Table 7.1. The production cost for various combinations are given is Table 7.2. Determine the optimal unit commitment policy to serve three stages of load curve. Note that only unit land unit-1 and unit-2 operate at the final stage of the load curve. **(15)**

Table7.1: 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 7.2: Production cost

Combination	Production cost (\$)		
	1100 MW	1400 MW	1800 MW
X_1	45848	58428	76472
X_2	45848	59356	79184
X_3	44792	58236	Infeasible
X_4	45868	Infeasible	Infeasible

8. (a) What are the two main functions of supplementary control? Draw the black diagram of a supplementary control scheme added to a generating unit. **(5)**

(b) Two 50-Hz systems are connected by a tie line with the following characteristics.

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

A load change of 100 MW occurs in Area –1. What is the new steady-state frequency? What is the change in tie line flow and total changes in generation? **(15)**

(c) What are the major objectives of an AGC? **(5)**

(d) Using the concept of speed-governing characteristic of a generator, show that the additional output of i-th unit due to load change can be expressed as: **(10)**

$$\Delta Pg_i = \frac{S_{Ri} / R_{iu}}{\sum_{k=1}^{n}\left(\frac{S_{Rk}}{R_{ku}}\right)} \times \Delta P$$

where n is the total no. of generators.

L-4/T-1/EEE **Date : 02/11/2019**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2018-2019

Sub : **EEE 485** (Power Transmission and Distribution)

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**.

All the symbols have their usual meanings.

1. (a) Consider a single-phase line composed of two composite conductors as shown in figure below. All strands in a conductor have same radius. Derive an expression for inductance of the line. State the assumptions made in deriving the expression. **(18)**

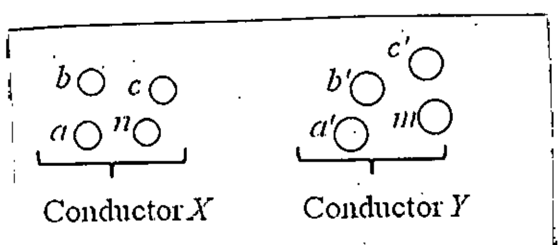

Fig. for Q. 1(a)

(b) The distance between conductors of a single-phase line is 10 ft. Each of its conductors is composed of six strands symmetrically placed around one center strand so that there are seven equal strands. The diameter of each strand is 0.1 inch. Show that geometric mean radius (GMR) of each conductor is 2.177 times the radius of each strand. Find the inductance of the line in mH/mile. **(12)**

(c) A three-phase line is designed with equilateral spacing of 16 ft. It is decided to build the line with horizontal spacing ($D_{13} = 2D_{12} = 2D_{23}$). The conductors are transposed. What should be the spacing between adjacent conductors in order to obtain the same inductance as in the original design? **(5)**

2. (a) Draw the schematic control diagram of a HVDC system and explain its operational characteristics. **(17)**

(b) Discuss the effects of ac voltages on dc link current in an HVDC link. **(10)**

(c) Assume two overhead ac and dc lines have same line length, made of same size conductors, transmit same amount of power and have same total thermal losses. AC line is 3-phase, has 3 wires, unity p.f. DC line has 2-wires plus ground return. Given that the K-factor values are, $K_1 = 2.5$ and $K_2 = 1.7$, determine. **(8)**

(i) Line-to-line dc voltage in terms of line-to-neutral voltage;

(ii) DC line current in terms of ac line current;

(iii) Ratio of dc insulation level to ac insulation level.

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3. (a) Briefly present the most commonly used insulator types in power transmission and distribution systems. **(8)**

   (b) Discuss the importance of improving string efficiency in suspension insulator. Consider a four disc insulator in a transmission line, show that the voltage across discs decreases progressively towards the cross-arm. **(15)**

   (c) A 3-phase transmission line is being supported by three disc insulators. The potentials across top unit and middle unit are 8 kV and 11 kV respectively. Calculate (i) the ratio of capacitance between pin and earth to the self-capacitance of each unit, (ii) the line voltage and (iii) string efficiency. **(12)**

4. (a) Present a comparison on radial-, ring-, and interconnected- distribution system. **(15)**

   (b) Discuss the factors affecting distribution loss. **(8)**

   (c) Discuss the loss reduction strategies used by power distribution utilities. **(12)**

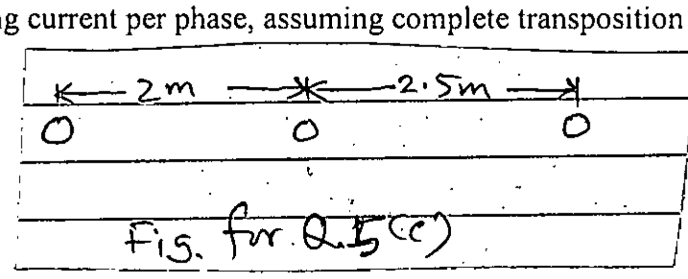
SECTION – B

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

5. (a) Derive an expression for the capacitance of a single phase overhead transmission line. **(10)**

   (b) Deduce an expression for line to neutral capacitance for a transposed 3-phase overhead transmission line when the conductors are unsymmetrically placed and the effect of earth is considered. **(15)**

   (c) A 3-phase, 50 Hz, 66 kV overhead line conductors are placed in a horizontal plane as shown in Fig. for Q. 1(c). The conductor diameter is 1.25 cm. If the line length is 100 km, calculate charging current per phase, assuming complete transposition of the line. **(10)**



6. (a) What is a sag in overhead lines? Discuss the disadvantages of providing too small or too large sag on a line. **(8)**

   (b) Deduce an expression for sag in overhead lines when supports are at unequal levels. **(12)**

   (c) A transmission line has a span of 150 m between level supports. The conductor has a cross-sectional area of 2 cm^2. The tension in the conductor is 2000 kg. If the specific gravity of the conductor material is 9.9 gm/cm^3 and wind pressure is 1.5 kg/m length, calculate the sag. What is the vertical sag? **(15)**

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7. (a) With a neat diagram show the various parts of a typical high voltage single core cable, Mention some commonly used insulation materials for cables. **(10)**

   (b) Derive an expression for the insulation resistance of a single core cable. **(10)**

   (c) Calculate the charging current of a single core cable used on a 3-phase, 66 kV system. The cable is 1 km long having a core diameter of 10 cm, and an impregnated paper insulation. of thickness 7 cm. The relative permittivity of the insulation may be taken as 4 and the supply at 50 Hz. **(15)**

8. (a) State the difference between equipment earthing and neutral earthing. What are the advantages of neutral grounding? **(10)**

   (b) Mention any three types of bus-bar arrangements used in substations. Illustrate your answer with suitable diagrams. **(15)**

   (c) Write a short note on the substation equipment. **(10)**
