L-4/T-II/EEE **Date : 27/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 411** (Power System II)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols carry their usual meaning. Assume reasonable values for any missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Briefly explain the working principles of UPFC and IPFC with proper illustrations. **(10)**

   (b) A 2 MW load is supplied power from a wind turbine generator through a transformer and a series compensated transmission line. Nominal frequency of the system is 50 Hz. Leakage and line reactance of the generator, transformer and line are X_g = 0.1 pu, X_T = 0.02 pu and X_L = 0.04 pu respectively, on 100 MVA, 400 kV base. -

   (i) Find the value of the series connected capacitor so that the resonance frequency of the line is 27.4 Hz. Also calculate the percentage compensation at nominal frequency. **(7)**

   (ii) If the line current contains 5^{th} and 7^{th} harmonics, what will be the percentage compensation at these harmonic frequencies? **(8)**

   (c) A ±30 MVAR Static VAR Compensator is connected to 132 kV 50 Hz system via a 132/6 kV transformer. The SVC consists of a 12-pulse TCR and three switched capacitor arms, tuned to the 5^{th}, 7^{th} and 11^{th} harmonics (the lowest harmonics produced by the TCR) and producing equal amounts of reactive power. Calculate the values of the passive components required for the TCR and the switched capacitor branch that is tuned for 11^{th} harmonic. **(10)**

2. (a) Develop the Q-V plot for a load to which power is supplied by a generator through a transmission line. Define reactive power margin from this plot. Also give explanation, which region of the plot indicates voltage stability. **(15)**

   (b) Describe a step-wise procedure to find the frequency response index (in MW/0.1 Hz) of a power system. **(15)**

   (c) For a single tuned passive filter (STPF), show that, $Q_{tot} = Q_L\left(\frac{f_1^2}{f_r^2 - f_1^2}\right)$, where the symbols have their usual meaning. **(5)**

3. (a) What is power outage? Suggest the configuration of the most desired and reliable solution to short term outage using UPS. Also describe briefly the features and operation of different voltage sag mitigation equipment. **(13)**

Contd P/2

EEE 411

Contd. Q. No. 3

(b) For a 11 kV 150 mm^2 overhead line, line impedance z = 310 mΩ/km. Determine the critical distance of the fault from the point of common coupling (PCC), if the fault level is 200 MVA. **(12)**

(c) (i) The following table shows propagation of voltage sag to higher voltage levels. Using the data of the 1st row, calculate the percentage values of A, B and C **(6)**

Propagation of Voltage Sag to Higher Voltage Levels

	Point of Common Coupling at:		
Fault at:	11 kV	33 kV	132 kV
400 V	90%	97.78%	99.33%
11 kV	–	A	B
33 kV	–	–	C

(ii) If the fault level at 400 V line is 200 MVA, determine the fault level at 11 kV and 132 kV line using the above table. **(4)**

4. (a) Explain the classical economic dispatch process of thermal power plants with transmission losses. (Hints: You can directly use the transmission loss equation, $P_L = \sum_{i=1}^{K} \sum_{j=1}^{K} P_{gi} B_{ij} P_{gj}$ where the symbols have their usual meaning) **(15)**

(b) Incremental fuel costs in $MWh for a plant consisting of two units are given by -

$$\lambda_1 = \frac{df_1}{dP_{g1}} = 0.008P_{g1} + 8.0; \quad \lambda_2 = \frac{df_2}{dP_{g2}} = 0.0096P_{g1} + 6.4$$

Assume that both units are operating at all times, total load varies from 250 MW to 1250 MW and maximum and minimum loads on each unit are to be 625 MW and 100 MW, respectively.

(i) Find the range (in MW) of the load for which the incremental fuel cost is same for both units. **(6)**

(ii) Estimate the economic allocation of load between the two units in each case, when load level is 250 MW, 900 MW and 1250 MW. **(9)**

(iii) Determine the saving in fuel cost in $/hour for the economic distribution of a total load of 900 MW between the two units you calculated earlier, compared with equal distribution of the same total load. **(5)**

SECTION – B

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

5. (a) Define power system stability. Explain the factors which affect the transient stability of power system. **(10)**

Contd P/3

EEE 411

Contd...Q. No. 5

(b) Derive the following relation which governs the rotational dynamics of a synchronous machine in power system stability. $\frac{2H}{\omega_s} \times \frac{d\omega}{dt} = P_m - P_e$ **(15)**

Where symbols have their usual meaning

(c) What is swing curve? Describe its significance. **(10)**

6. (a) What is critical clearing time? Using the equal area criterion for a typical single machine infinite bus systems when fault occurs at the sending end bus, derive the following relation.

$$t_{cr} = \sqrt{\frac{4H(\delta_{cr} - \delta_0)}{\omega_s P_m}} \quad \textbf{(10)}$$

(b) A 50 Hz generator is supplying 60% of P_{max} to an infinite bus through a reactive network. A fault occurs which increases the reactance of the network between the generator internal voltage and the infinite bus by 400%. When the fault is cleared, the maximum power that can be delivered is 80% of the original maximum value. If P_m is 1.0 per unit power, determine the critical clearing angle for the condition described. **(7)**

(c) If the generator of Q 6(b) has an inertia constant of H=5MJ/MVA find the critical clearing time for the condition Q6(b). Use frequency f=50Hz and Δt=0.05 second. **(16)**

7. The generator G in the power system in Fig. 7(a) is delivering 1.0 per unit power to the infinite bus. The numbers on the diagram indicate values of reactance on a common system base. If a three phase fault occurs in the system at a point of transmission line L2 which is at a distance of 40% of the line length away from sending end terminal of the line. If H=5 MJ/MVA and frequency f=50Hz, determine **(18+10+7)**

(i) Power angle equation during fault

(ii) Swing equation if fault is cleared by line outage

(iii) Synchronizing power coefficient

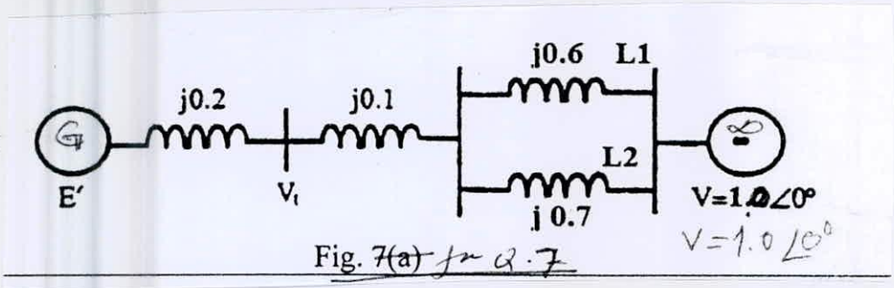

Fig. 7(a) for Q.7

Fig for Q. No. 7

EEE 411

8. A 13.8kV, 50MVA, 0.8 pf lagging, 50Hz, four pole, Y connected synchronous generator has direct axis reactance of 2.5 Ω and quadrature axis reactance is 1.8Ω, armature resistance of 0.2Ω. Friction, windage and stray losses may be assumed negligible. The generators open circuit characteristic is given in Figure for Q. 8.

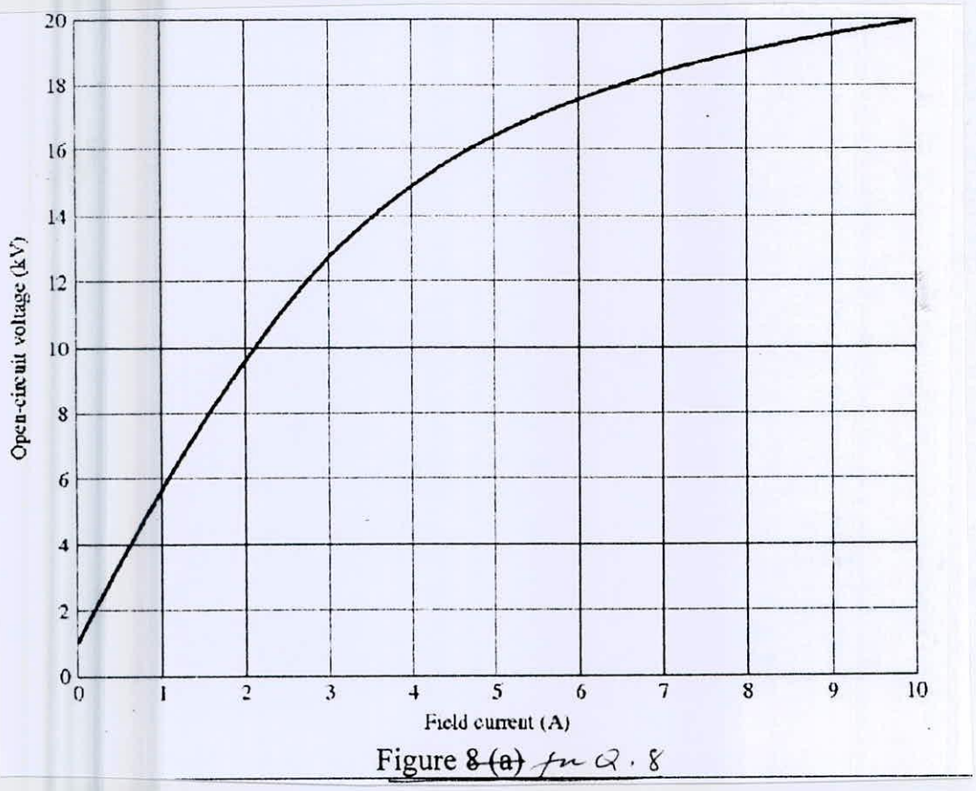

Figure ~~8 (a)~~ for Q. 8

(i) How much field current is required to make line voltage equal to 13.8kV? **(5)**

(ii) What is the internal generated voltage of this machine when it is operating at rated condition? **(10)**

(iii) What is the voltage regulation of this generator at rated condition? **(5)**

(iv) What fraction of this generator's full load power is due to reluctance torque of the rotor? **(5)**

(v) Sketch the torque vs torque angle for this machine. **(5)**

(vi) If the machine is running as a motor at the rated conditions, what is the maximum torque that can be drawn from its shaft without it slipping poles when the field current is zero? **(5)**

L-4/T-2/EEE **Date : 29/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 425** (Biomedical Signals, Instrumentations and Measurement)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

Symbols and abbreviations have their usual meaning.

1. (a) Define HRV and write its significance on human health. With neat diagrams, describe the analysis of HRV by spectral and geometric methods. **(15)**

   (b) Define blood pressure. With neat diagram, describe an extra-vascular BP measuring system. Draw the block diagram of a diastolic BP measurement system and describe its operation. **(15)**

   (c) Define normal and abnormal heart sounds. **(5)**

2. (a) Define cell, tissue and organ. With neat sketches, explain the ionic characteristics of human cell. Explain different levels and intervals of a typical bioelectric potential in human cell. **(15)**

   (b) Define transducer and classify it. With neat diagrams, describe the application areas and working of capacitive and piezoelectric transducers to measure signals of human body. **(15)**

   (c) Write the basic requirements of a bio-potential amplifier. **(5)**

3. (a) Write the bioelectric basis of impedance plethysmography. With neat diagrams, describe the use of change in tissue impedance to determine cardiac stroke volume. **(15)**

   (b) Name the factors that change the normal shapes of ECG. With neat sketches, explain the changes in ECG due to ventricular fibrillation and bundle block. **(15)**

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

4. (a) Distinguish among EEG, ECoG and ENG. Briefly describe the measurement and processing of EEG using 40-60 electrode system. **(15)**

   (b) Name the general tests of blood performed in pathological laboratory. With diagrams, describe different components and working principle of a flame photometer. **(15)**

   (c) Write a short note on natural pacemakers. **(5)**

Contd P/2

EEE 425

SECTION – B

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

Symbols and abbreviations have their usual meanings.

5. (a) Mention some common biosignals (at least five) and the basic information each signal represent. With examples, briefly discuss in your role as an electrical and electronic engineer in a hospital in relation to biomedical instrumentation and measurement. **(20)**

   (b) Briefly explain the major anatomical planes for the measurement of biosignals with appropriate examples. **(15)**

6. (a) Compare the following scanning modes of ultrasonography: (i) A-modes, (ii) B-mode and (iii) M-mode. Where do we use Color Doppler and CW Doppler ultrasonography and why? **(20)**

   (b) A patient is having difficulty in breathing during exercise and chest discomfort with sudden increase in physical activity. ECG and X-ray were performed on the patient (Who is about 60 years old), that was inconclusive. However, an echocardiogram confirmed that he had mitral stenosis-narrowing of the valve between the left heart chambers. Explain why the results of X-ray and ECG were inconclusive? Would an MRI be useful in this regard? **(15)**

7. (a) Briefly describe the various generations of computed tomography. Compare their relative advantages and disadvantages. **(20)**

   (b) How does blurring occur in X-ray images? Explain with necessary diagrams. **(15)**

8. (a) Mention the major human body systems and their main functions. Lung ultrasound has recently been used in COVID-19 diagnosis employing portable ultrasound scanners. Comment on its use as compared to a CT machine. **(20)**

   (b) Write short notes on any two of the following: **(15)**

   (i) Electrode contact noise and electrosurgical noise.

   (ii) Noise models

   (iii) Comparison of SPECT and PET/CT

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 437**(Wireless 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**.

The symbols have their usual meanings. Answer briefly and to the point.

1. (a) Starting from the voltage signal, derive the expression of average SNR for EGC of M branches each with average SNR of Γ. **(17)**

   (b) An engineer first designed a system with EGC of 4 branches and obtained an average SNR of 12 dB. Then the engineer modified the system for MRC by incorporating the tuning features of the gains of each branch. What will be the average SNR and the outage probability for the newly designed MRC system? Also, determine the SNR gains of MRC compared to EGC and SC. **(18)**

2. (a) Determine whether S_4 is OSTBC or not. **(10)**

$$\mathbf{S}_4 = \begin{bmatrix} s_1 & s_2 & s_3 & s_4 \\ -s_2 & s_1 & -s_4 & s_3 \\ -s_3 & s_4 & s_1 & -s_2 \\ -s_4 & -s_3 & s_2 & s_1 \\ s_1^* & s_2^* & s_3^* & s_4^* \\ -s_2^* & s_1^* & -s_4^* & s_3^* \\ -s_3^* & s_4^* & s_1^* & -s_2^* \\ -s_4^* & -s_3^* & s_2^* & s_1^* \end{bmatrix}.$$

   (b) Draw the block diagrams of an OFDM transmitter and receiver. Explain the operation of an OFDM system. **(15)**

   (c) Explain the depending factors of selecting block length and cyclic prefix length in OFDM. What are the advantages of OFDMA compared to OFDM? **(10)**

3. (a) Explain the system model and capacity computation method for flat-fading static MIMO channel when both the transmitter and receiver know CSI. **(17)**

   (b) Consider a 4×3 flat-fading MIMO channel where only the receiver knows CSI. There are four possible states of the channel-**H1**, **H2**, **H3** and **H4** with probabilities 0.3, 0.2, 0.4, 0.1, respectively. The diagonal elements of diagonal matrix by Eigen decomposition of

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EEE 437

Contd. Q. No. 3(b)

channel matrices **H1**, **H2**, **H3** and **H4** are found to be {4, 3, 2}, {3.5, 3, 2.5}, {4.5, 3.5, 2.5}, and {4.5, 3, 2.8} respectively. Determine the ergodic capacity of the channel in bps/Hz if the average SNR of each receiver antenna, E_s/N_0, is 12 dB. **(18)**

4. (a) Describe the architecture of LTE. **(11)**

(b) Suppose, an operator uses 5 MHz LTE bandwidth for downlink with extended CP based OFDM technique. The total number of users in a cell site is 100, and the data transmission rate for each resource block is 6 Mbps.

Determine (i) the number of resource elements, (ii) the maximum number of users in downlink that can be supported in one frame, and (iii) the average downlink throughput capacity of each user under round robin scheduling. **(12)**

(c) Describe the operation of the SIC receiver and mention its advantages and disadvantages. **(12)**

SECTION – B

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

All the symbols have their usual meanings. Q Table is attached. Assume reasonable values for missing data.

5. (a) Explain Doppler Shift. Consider a transmitter which radiates a sinusoidal carrier frequency of 1850 MHz. For a vehicle moving at 70 mph, compute the received carrier frequency if the vehicle is moving (i) directly towards the transmitter, (ii) directly away from the transmitter, (iii) in a direction which is perpendicular to the direction of the arrival of the transmitted signal. **(3+9=12)**

(b) Consider a wideband channel with multipath intensity profile as **(12)**

$$A_C(\tau) = \begin{cases} e^{-100\tau} & \tau \geq 0 \\ 0 & else \end{cases}$$

Find the mean and rms delay spreads of the channel and find the maximum symbol period such that a linearly modulated signal transmitted though this channel does not experience ISI.

(c) Explain small scale fading and write down the factors that influence the small scale fading. Also, describe the mathematical model used to represent small scale fading? **(5+6=11)**

6. (a) Define channel capacity. The joint probability of a system is given in the following. Find marginal entropies, joint entropy, mutual information and channel capacity. **(18)**

Contd P/3

EEE 437

$$P(X,Y) = \begin{array}{c} \\ x_1 \\ x_2 \\ x_3 \end{array} \begin{array}{c} \begin{array}{cc} y_1 & y_2 \end{array} \\ \begin{bmatrix} 0.5 & 0.25 \\ 0 & 0.125 \\ 0.0625 & 0.0625 \end{bmatrix} \end{array}$$

(b) Consider a flat-fading channel with i.i.d. channel gain g[i] which can take on three possible values: sqrt(g_1) = 0.15 with probability p_1=0.1, sqrt(g_2)=0.6 with probability p_2=0.65, and sqrt(g_3)=0.9 with probability p_3=0.25. The transmitter power is 10 mW, the noise spectral density $N_0=10^{-9}$ W/Hz, and the channel bandwidth 30 kHz. Assume the receiver has the knowledge of the instantaneous value of g[i], but the transmitter does not. Find the Shanon capacity of this channel and compare the capacity of an AWGN channel with same average SNR. **(17)**

7. (a) Consider a flat-fading channel with i.i.d. channel gain g[i] which can take on four possible values: sqrt(g_1)=0.15 with probability p_1=0.05, sqrt(g_2)=0.6 with probability p_2=0.45, sqrt(g_3)=0.8 with probability p_3=0.25, and sqrt(g_4)=1 with probability p_4=0.25,. The transmitter power is 20 mW, the noise spectral density $N_0=10^{-9}$ W/Hz, and the channel bandwidth 40 kHz. Assume the receiver has the knowledge of the instantaneous value of g[i], but the transmitter does not. Find the capacity versus outage probability plot for this channel, and the average rate correctly received for outage probabilities $p_{out} < 0.1$, $p_{out} = 0.5$, $p_{out} = o.8$. **(18)**

   (b) Derive symbol error rate for MPAM and MQAM for an AWGN channel. **(17)**

8. (a) Deduce the outage probability for Rayleigh fading channel. Determine the required γ_b for BPSK modulation in slow Rayleigh fading such that 98% of the time $p_b(\gamma_b) < 10^{-4}$. **(18)**

   (b) Derive the average bit error rate (BER) for BPSK in Rayleigh fading channel. Draw the average BER versus average SNR curve for AWGN and Rayleigh fading channel and explain the impact of fading. **(17)**

L-4/T-II /EEE **Date : 03/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

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. Assume reasonable values for missing data.

1. (a) With neat diagrams briefly state the operation of carbon microphone and condenser microphone. Identify the type of microphone, speaker and ringer used in cellular mobile phone. **(10+2)**

   (b) How is a telephone set connected to the local exchange using transmission bridge? Why is a telephone -48 V (dc) chosen for central battery of exchange and why is the positive terminal of battery grounded? **(4+4+4)**

   (c) Summarize the five design considerations for touch-tone dialing. **(11)**

2. (a) Draw the mechanism of keeping side tone in a telephone set. How the amount of side tone can be tuned? **(8+2)**

   (b) Why is 2-wire to 4-wire conversion necessary and how is implemented? How is it possible to use 2-wire line in a local loop for a particular subscriber? Explain with necessary diagrams. **(4+5+4)**

   (c) What are the major control functions carried out by CCS of a Crossbar system? With a functional block diagram point out the said functions. **(2+10)**

3. (a) How does an SPC based exchange work? "Load sharing configuration of centralized SPC is a step towards distributed control", explain the statement with appropriate figures. **(2+10)**

   (b) With an example, explain how multistage switching reduces the total number of cross -points. Compare the performance of multistage switching with single-stage switching. **(5+4)**

   (c) Determine the total number of crosspoints required for lines (inlets) of $N = 2048$ considering single-stage switch, and calculate the minimum number of crosspoints required by a non-blocking three-stage switch. For the three-stage switch, if those inlets are sub-divided into 32 blocks, inlet utilization is 70% and the space expansion factor is 1.15625, calculate the probability that an inter-stage link is busy, number of inter-stage links, the blocking probability of this network and the total number of crosspoints for the network. Comment on the results of crosspoints obtained in different cases and suggest any way to reduce the total number of crosspoints further. **(14)**

Contd P/2

EEE 441

4. (a) Draw a digital memory or TSI switch and show its operation in the diagram only. For an 8-kHz sampling rate, calculate the maximum number of full-duplex channels that can be supported by the memory switch. Consider the use of 25-ns memory (RAM). Using nonblocking three-stage switch, how many cross crosspoints could be required to achieve this equivalent memory switch? **(8+5)**

   (b) Draw a typical two-dimensional (2-D) switch, and explain why 2-D switching is necessary. In a TS switch, the number of TDM input lines is 32 and each line contains 3 DS1 signals. Determine the number of bits and crosspoints required for the space stage and the same for the time stage. Also, calculate the implementation complexity and comment on how to reduce the complexity. Assume single-stage matrix for the space stage. **(5+10)**

   (c) State the purpose of multiple-stage time and space switching Also, justify which one is better between the STS and TST switching. **(7)**

SECTION – B

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

Answer in brief and to the point.

5. (a) Consider a group of 24 subscribers that generates 30 calls in a bufferless telecommunication system of 4 lines. The average holding time of each call is 3 min. A call is cleared immediately if it does not have service. Determine (i) the probability that 5 calls arrive during busy hour, (ii) blocking probability, and (iii) the probability that at least one line is busy. **(15)**

   (b) Explain the ISDN services with its advantages and disadvantages. **(10)**

   (c) Explain the operation of B-Channel and D-Channel of ISDN using the detailed diagram of the ISDN circuit switching concept. **(10)**

6. (a) Compare between circuit switching and packet switching. **(12)**

   (b) Briefly describe SDH layers and their functions. **(11)**

   (c) By using an appropriate diagram, describe the network configurations of SONET. **(12)**

7. (a) Show the structure of Header for an ATM cell and briefly describe the functions of each field. **(17)**

   (b) Briefly explain the functions of ATM layer, ATM adaptation layer and Physical layer of ATM. **(18)**

8. (a) Write down the advantages and disadvantages of IP telephony. **(11)**

   (b) Briefly describe the VoIP signaling protocols. **(12)**

   (c) Briefly describe the DTH technology mentioning the functions of all the elements. **(12)**

L-4/T-II/EEE **Date : 10/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 443** (Radar and Satellite 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**.

Answer in brief and to the point. Symbols and abbreviations have their usual meanings.

1. (a) Answer each of the following questions in brief: **(6×3=18)**

(i) Mention the objectives and the most important function of a radar.

(ii) In brief statements, enumerate the major applications of radar.

(iii) Define range and write down the simple equation for determining the range of a target?

(iv) Determine the maximum unambiguous range as a function of the pulse repetition frequency, f_p. Also, plot the former for f_p = 500 Hz, 1000 Hz, and 1500 Hz in a linear scale.

(v) If the peak power of a radar transmitter is 1 MW, and the duty cycle is 10%, determine the average power of the transmitter. Which power term is more important in radar and why?

(vi) If the transmitter power, P_t, of an isotropic antenna is 2 MW, calculate the power density of a target at a distance of 1.5 km.

(b) With an appropriate block diagram, briefly describe the operation of a modern radar. What is clutter? Name the principle by which a radar can distinguish between a clutter and a target. Using a neat diagram, show the relative power versus velocity of some typical clutters and target. Also, name the major factors that may affect radar performance. **(6+4+4+3)**

2. (a) Name the various types of radar according to their usage. With a neat sketch describe the operation of a synthetic aperture radar or an airport surveillance radar. What is polarization in electromagnetic radiation? How can a Doppler weather radar extract more information of the target using the polarization techniques? **(4+8+5)**

(b) What is Jones vector? Define the channel- or scattering matrix for a 2×2 TDM-MIMO radar in terms of the relevant s-parameters. For the 3×3 TDM-MTMO transmitter and receiver pairs shown in Fig. for Q. No. 2(b), determine the equivalent virtual array and show it in a neat diagram. **(5+6)**

Also, determine the following S-parameters of the scattering- or channel matrix corresponding to the above radar configuration: **(7)**

Contd P/2

EEE 443

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

$$\begin{pmatrix} S_{11} & S_{12} & S_{13} \\ S_{21} & S_{22} & s_{23} \\ s_{31} & s_{32} & s_{33} \end{pmatrix}$$

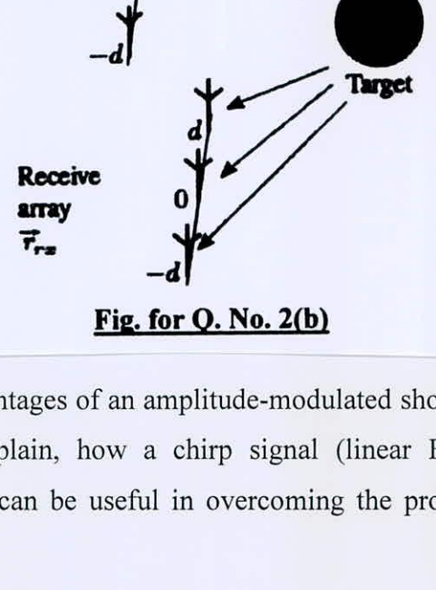


Fig. for Q. No. 2(b)

3. (a) Mention the disadvantages of an amplitude-modulated short pulse and a long pulse as a radar waveform. Explain, how a chirp signal (linear FM) along with the pulse compression technique can be useful in overcoming the problems of the two types of pulse.

For a binary phase-coded waveform [+1 +1 −1], (where, the pulse duration, $T = 3\ T_{CHIP}$), determine and draw the output values from the delay-line receiver, as shown in Fig. for Q. No. 3(a) at the sample instants ($t = 0$ to $t = 6T_{CHIP}$). **(7+10)**

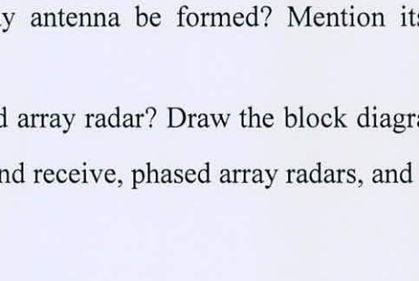


Fig. for Q. No, 3(a)

(b) With a suitable sketch, define the following terms: detection threshold, false alarm, detected target, missed target and *rms* noise level. Also, comment on how to decide the appropriate threshold value for detecting the target correctly.

How can a phased-array antenna be formed? Mention its advantages over the other antennas.

What is an active phased array radar? Draw the block diagrams of the digital on receive, and digital on transmit and receive, phased array radars, and explain where they are used. **(6+4+8)**

EEE 443

4. (a) Write the significance of S/N. Write down the track- and search radar range equations in the forms of S/N and explain all the terms. Show that an airport surveillance radar with the parameters shown in Table for Q. No. 4(a) will have an S/N of 1.3 dB per pulse. From this result, compute the total S/N in dB for the 21 pulses (in a beamwidth) **(7+10)**

Table for Q. No. 4(a)

Parameter	Value	Additional Information
Range	60 nmi	Use 1 nmi = 1851.85m.
Aircraft Cross Section	1 m^2	
Peak Power	1.4 MW	Compute λ and the antenna gain, G, considering a beam shaping loss of 9 dB.
Duty Cycle	0.000525	
Pulse Width	0.6 μS	
Bandwidth	1.67 MHz	
Frequency	2800 MHz	Number of pulses per beamwidth = 21.
Antenna Rotation Rate	12.8 RPM	
Pulse Repetition Rate	1200 Hz	
Antenna size	(width x height) = 4.9m x 2.7m	
Azimuth Beamwidth	1.35°	
System Noise Temperature	950° K	
Additional Losses	8 dB	

(b) What is GPS? Briefly explain the basic principle of how a GPS system detects the position of an object on and above the earth's surface.

Draw a simplified block diagram of a C/A code generator used on GPS satellites and mention the functions of each block.

Also, explain how a single-channel correlator in a GPS receiver-extracts the 50 bps navigation signal transmitted from the GPS satellite. **(6+6+6)**

SECTION – B

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

All the symbols have their usual meanings. Assume reasonable values for any missing data.

5. (a) Ascertain the unique features of communication satellite, particularly satellites for applications like weather forecasting navigation and localization. What are the impairments of satellite communication? **(8+2)**

(b) With neat diagrams, identify the different segments of a satellite system and briefly write down about the major components or blocks of a satellite. **(13)**

(c) How to define the location of a satellite in space? With neat sketches, define elevation, azimuth, Zenith and Nadir directions.

Sketch different types of satellite orbits (also label Apogee and Perigee, if appropriate) an mention their features. **(3+4+5)**

Contd P/4

EEE 443

6. (a) Mention three standard launching methods of a satellite. Describe a launching method and placing of a satellite in a geostationary orbit with necessary figure. **(2+11)**

   (b) Draw the functional block diagram of a double frequency conversion bent-pipe transponder for 14/11 GHz band and briefly describe its operation. **(10)**

   (c) Name and sketch the major types of antennas used on satellite and state their purposes. **(12)**

7. (a) Draw the schematic of a VSAT system and describe its operation. Identify the type of satellite for mobile communication, and mention the features and applications of these satellites. **(8+7)**

   (b) Why multiple access technology is required for satellite communication? What are the conflict-free multiple access techniques and why are they called conflict-free? With example explain how a conflict-free access technique is implemented in satellite communication. **(2+4+4)**

   (c) A geostationary satellite carries Ka-band transponder which transmits 20 W into an antenna with an on-axis gain of 30 dB. An earth station is in the center of the antenna beam from the satellite, at a distance of 38,000 km. For a frequency of 20.0 GHz. **(10)**

   (i) Calculate the incident flux density at the earth station in watts per square meter and in dBW/m^2.

   (ii) The earth station has an antenna with a circular aperture 2 m in diameter and an aperture efficiency of 70%. Calculate the received power level in W and in dBW at the antenna output port.

   (iii) Calculate the on-axis gain of the antenna in dB.

   (iv) Calculate the free space path loss between the satellite and the earth station.

   (v) If system noise temperature is 100 K and noise bandwidth is 30 MHz, calculate the G/T and C/N in dB.

8. (a) Write the purposes of satellite networks and distinguish between star and mesh networks. Illustrate a satellite network for digital audio and video broadcast (DBS-TV). **(12)**

   (b) Show the block diagram of a satellite earth station and briefly describe the operation in transmission side. **(10)**

   (c) Design a C-band receiving earth station to provide an overall clear air C/N of 13 dB in a 27 MHz IF noise bandwidth at a carrier frequency of 4.06 GHz. The antenna noise temperature is 20 K and the LNA noise temperature is 55 K. You may assume a high gain LNA and ignore the noise generated in other parts of the receiver. The C-band satellite transponder is operated with 1 dB output backoff. Clear air atmospheric attenuation on the downlink and other losses .5 dB is (total).

Contd P/5

EEE 443

Contd...Q. No. 8(c)

Determine the diameter of the receiving antenna, assuming an aperture efficiency of 65%. The receiving terminal is located on the 3-dB contour of the satellite footprint. Under conditions of heavy rain, the C-band path to the receive station suffers an attenuation of 1.5 dB. Assuming 100% coupling of sky noise into antenna noise, and 0.3 dB clear air gaseous attenuation, calculate the overall C/N under these conditions, and find the downlink margin. **(13)**

L-4/T-II/EEE **Date : 03/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 451** (Processing and Fabrication Technology)

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. Answer briefly and to the point.

1. (a) Prove the Fick's Laws on diffusion. **(21)**

   (b) What are the importances of diffusion as a physical phenomenon? What is the Frank-Turnbull method of diffusion? **(7+7)**

2. (a) Draw and describe the full equipment of ion implantation process. **(20)**

   (b) There are two high-intensity optical sources for thermal annealing. Describe these two sources. **(15)**

3. (a) Draw and discuss the gas-manifold used in generic oxidation or diffusion systems. **(18)**

   (b) "It has been observed that, generally low-temperature and reduced-time anneals of implanted species produce chemical junctions that are deeper than simple diffusion theory" – please explain. **(10)**

   (c) What are the drawbacks of negative photoresist? **(7)**

4. (a) Draw the process flow-diagram of phosphoric oxide deposition including temperature changes and gas flows. **(12)**

   (b) What are the limitations of optical lithography? Why non-optical lithography techniques are being developed? Name a few important non-optical techniques. **(7+7+5)**

   (c) Why lift-off process can be detrimental to chip fabrication? **(4)**

SECTION – B

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

5. (a) What chip characteristics affect the packaging process? Name the basic functions performed by a semiconductor package. **(14)**

   (b) Briefly describe, what is epoxy die attach. **(10)**

   (c) Describe gold wire bonding. **(11)**

6. (a) Describe the various methods of package sealing. **(22)**

   (b) What are the major contamination sources? **(8)**

   (c) How does a HEPA filter work? **(5)**

Contd P/2

EEE 451

7. (a) What are the important physical vapor deposition techniques that you know? Describe briefly. **(25)**

   (b) What are the differences of MBE and MOCVD methods of deposition? **(10)**

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

   (a) CMOS MEMS Fab Technologies.

   (b) MEMRISTOR Fabrication.

   (c) Double-patterning.

   (d) Soft Lithography.

   (e) AI in Fabrication.

L-4/T-II/EEE **Date : 29/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

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) What is "virtual crystal approximation"? Draw PL and absorption spectra of GaAs and GaP semiconductors and compare probability of radiative and non-radiative transitions in these semiconductors. Show E-k diagram of GaAs and GaP and explain the effect of nitrogen incorporation in terms of probability of the radiative and non-radiative transitions. **(20)**

   (b) Draw basic configuration of an up-converter and discuss the emission spectra before and after up-conversion process. Calculate the angle between the transmission axes of two polarizers for the transmitted light intensity through both polarizers to be 80%, and 40%. **(15)**

2. (a) What is pumping in a lasing system? With neat diagram, explain transitions in an ideal three-level lasing system and write rate equations. Discuss the merits and demerits of three-level lasing system to those of two level and four-level lasing systems in terms of pumping requirements to attain population inversion. **(20)**

   (b) Consider an InGaAsP FP laser diode operating at λ = 1320 nm for optical communications. The threshold current is 6 mA. At I = 25mA, the output optical power is 6 mW and the voltage across the diode is 1.2 V. Calculate external quantum efficiency (QE), external differential QE, power conversion efficiency, and the slope efficiency of the diode. What is the forward diode current that gives an output optical power of 3 mW? **(15)**

3. (a) Compare threshold current and transparency current of laser diodes. Elaborate that these currents are improved in DH laser diodes to that of homojunction laser diodes. Draw VCSEL structure and explain its operation principle. Why does a real DBR laser have only a single mode? **(20)**

   (b) A DFB laser that has a corrugation period Λ of 0.2 μm and a grating length of 400 μm. Suppose that the effective refractive index of the medium is 3.5. Assuming a first-order grating, calculate the Bragg wavelength, the mode wavelengths, and their separation. **(15)**

Contd P/2

EEE 459

4. (a) With neat diagrams, discuss propagation of o-wave and e-wave through birefringent and dichroic crystals. Sketch schematically the structure of a transverse Pockels cell intensity modulator and explain its operation principle. What is the required applied voltage for full transmission? **(20)**

(b) Design a heterojunction solar cell using InP and InGaAs semiconductors. A solar cell operating at 700 W m^{-2} solar radiance has a short circuit current Isc of 20 mA and an open circuit output voltage Voc of 0.60 V. What are the short circuit current and open circuit voltages when the light intensity is 300 W m^{-2}? If the solar cell operates with an efficiency of 20% under this condition, calculate the fill factor. The illuminated area of the solar cell is 2 cm × 3 cm. Assume $\eta = 1$. **(15)**

SECTION – B

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

All the symbols have their usual meanings. Assume reasonable values for missing data.

5. (a) Briefly explain the reason why the output spectrum of a typical practical LED is different from that of an idealized one. Draw the *E-k* diagram of an ideal LED that may have a symmetric output spectrum. **(12)**

(b) Varshni constants for $In_{0.47}Ga_{0.53}As$ are E_{g0} = 0.814 eV, $A = 4.906 \times 10^{-4}$ eVK^{-1} and B = 301 K. Determine and explain the rate of change of emitted wavelength from an $In_{0.47}Ga_{0.53}As$ LED as a function of temperature. Assume that the actual position of the peak emitted photon energy is $0.5k_BT$. **(15)**

(c) Compare the output spectra of an edge-emitting LED with a surface-emitting LED. **(8)**

6. (a) Explain Schokley-Ramo Theorem in the context of external photocurrent in a photoconductor. **(12)**

(b) Draw the schematic and band diagram of an InGaAs and InP based *SAGM* (Separate Absorption, Gain and Multiplication) *APD* (Avalanche Photodetector) with proper labeling. Band gap of InP, InAs and GaAs are 1.35 eV, 0.35 and 1.41 eV. For InP the impact ionization coefficients are roughly given by $\alpha_e = 9.2 \times 10^6 \exp(-3.44 \times 10^6/E)$ and $\alpha_h = (4.3 \times 10^6)\exp(-2.72 \times 10^6/E)$, where α_e and α_h are in cm^{-1} and E is in Vcm^{-1}. The avalanche is initiated by holes in *N*-InP of the mentioned SAGM APD. The width of the N-layer is 1 μm and the applied field is 4.6×10^5 V cm^{-1}. **(23)**

(i) What is the multiplication, *M*?

(ii) If the field is increased by 2%, how much is M increased?

(iii) If the width of the *N*-Layer is doubled, how is *M* changed?

Contd P/3

EEE 459

7. (a) Consider a GaAs Quantum Well (QW) sandwiched between two A1GaAs layers. The gaps of GaAs and A1As are 1.42 and 2.16 eV, respectively. Effective masses of electrons and holes in GaAs are $0.067m_e$ and $0.5m_e$, respectively. The width of the QW is 12 nm. **(18)**

   (i) If we consider the radiative recombination of carriers from the first electronic energy level to the first hole energy level, determine the emission wavelength assuming an infinite potential Well. How does the emission wavelength change with the width of QW?

   (ii) What are the limitations of such an LED? How can multiple quantum well LED solve these problems? Compare the output power vs. current characteristics for these two devices.

   (b) Describe briefly with necessary diagrams the Frank-Condon principle in the context of Photoluminescnece. **(17)**

8. (a) Define 1/f noise and Noise Equivalent Power (NEP). Consider a fast Ge pn junction photodiode, which is illuminated by an LED. The PD is reverse biased for photodetection and has a dark current of 0.5 μA with peak responsivity 0.7 AV^{-1} at 1.55 μm. The bandwidth of the detector is 100 MHz. **(20)**

   (i) Calculate the NEP of the photodiode at the peak wavelength.

   (ii) Find the minimum light intensity that gives a SNR of 1.

   (iii) Suppose the LED has active layer with p-type doping concentration $2 \times 10^{17}\ cm^{-3}$ and non-radiative lifetime of 100 ns. The extraction efficiency and luminous efficiency of the LED are 20% and 5%, respectively. Find the forward current of the LED for the minimum light intensity found in (ii). Assume $B = 2 \times 10^{-16}\ m^2s^{-1}$.

   (b) Briefly explain Auger non-radiative recombination process with necessary diagrams. **(15)**

L-4/T-II/EEE **Date : 10/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 461** (Semiconductor and Nano Device)

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 the transition of an electron due to interaction with a photon be considered vertical in the *k*-space? **(10)**

   (b) Discuss how the electron distributions in the interacting energy levels affect the net transition rate when photons interact. **(13)**

   (c) What is the joint density of states? Compare the joint density of states for interband and inter-subband transitions. **(12)**

2. (a) Can the electron-optical phonon scattering mechanism be approximated as quasi-elastic? Explain. **(10)**

   (b) Why can electronic transport through a two-dimensional material, such as grapheme, be much faster than a three-dimensional material? What can be expected for a one-dimensional material? **(13)**

   (c) A 10 nm thick 0.3 eV A1GaAs barrier separates two regions of GaAs. Calculate the transmission profile through the barrier. How sensitive is the result to monolayer fluctuations (±0.3 nm) in the barrier thickness? **(12)**

3. (a) Draw the typical current-voltage relationship of a resonant tunneling diode. Identify the negative differential resistance region. Explain why there is a negative differential resistance behavior of a resonant tunneling diode. **(10)**

   (b) Calculate the oscillator strength for the transition from the ground state ($n = 1$) to the first excited state ($n = 2$) and second excited state ($n = 3$) in a 10-nm-thick infinitely deep quantum well. Discuss which of these two levels should be chosen for designing a photodiode. **(13)**

   (c) Derive the electron transition rate from an initial state i to a final state f due to perturbing photon. **(12)**

4. (a) Explain how data can be written and erased in a flash memory device. **(10)**

   (b) Show that the current through a square potential barrier is not simply proportional to the applied bias. **(13)**

   (c) Derive the T-matrix for a step potential between two semi-infinite materials. **(12)**

Contd P/2

EEE 461

SECTION – B

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

All the symbols have their usual meanings.

5. (a) Illustrate the bonding formation using force and energy diagram. Show that at equilibrium, the net energy should be negative. **(15)**

   (b) What is the required property of a wave that is free from dispersion? What is the consequence of periodic dispersion? **(20)**

6. (a) What happens to the energy of the attenuated waves above the cutoff frequency? Can energy propagate through the crystal slightly above the cutoff frequencies? Explain. **(20)**

   (b) What is the consequence of a finite number of atoms in the dispersion relation? Show the dispersion relations for both the transverse and longitudinal waves. **(15)**

7. (a) Show the dispersion relation for a diatomic lattice. Discuss about the motion of neighboring atoms of a diatomic lattice at long wavelengths. **(15)**

   (b) What is the effect of reasonance when a polar crystal is optically excited? What is the Reststrahlen effect? **(20)**

8. (a) What are the assumption of Debye theory of specific heat? Compare the specific heat calculated by classical and quantum theories. **(15)**

   (b) What are the assumptions of free electron model? Show that the effective mass of a particle depends on the curvature of the energy band. **(20)**

L-4/T-II/EEE **Date : 27/03/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 467** (VLSI Circuits and Design)

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) For the code shown below, what will be the output in the standard display? **(15)**

```
module display;
 int a,b;
 initial begin  //initial block executed at start
        a = 10;
        b = 15;
        $display("\tBefore Assignment :: Value of a is %0d",a);
        $display("\tBefore Assignment :: Value of b is %0d",b);
        a <= b;
        b <= 20;
        $display("\tAfter  Assignment :: Value of a is %0d",a);
        $display("\tAfter  Assignment :: Value of b is %0d",b);
 end

 final begin
        $display("\tEnd of Simulation :: Value of a is %0d",a);
        $display("\tEnd of Simulation :: Value of b is %0d",b);
        $display("-----------------------------------------------");
 end
 endmodule
```

(b) You have to design a synchronous circuit based on a Finite State Machine (FSM) that will produce a single output pulse at its primary output ***P*** whenever its primary input ***s*** is taken to logic 1. In addition, a primary output ***L*** is to be set to logic 1 whenever input ***s*** is taken to logic 1 and cleared to logic 0 after the input ***s*** is released to logic 0 i.e. output ***L*** acts as a memory indicator to indicate that a pulse has just been generated. Block diagram of the single-pulse with memory FSM is shown in Fig. for Q. No. 1(b). Write the state diagram and the Verilog code of the circuit. **(20)**

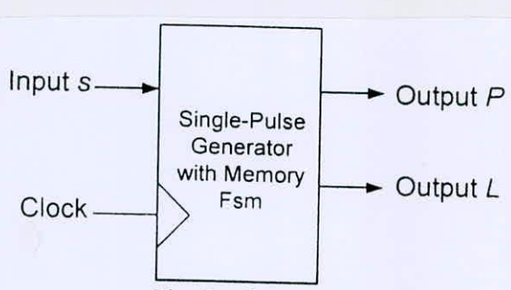
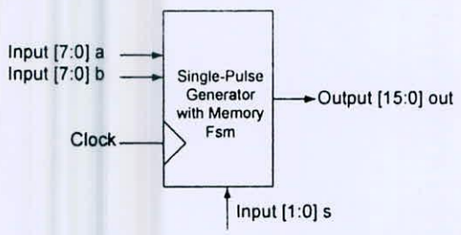


Fig. for Q. No 1(b)

Contd P/2

EEE 467

2. The design group in your team designed an alu with the specification shown in Fig. for Q. No. 2. **(10)**



OpCode [s]	Clock	Operation
00	⌐¯¯¯	Addition
01	⌐¯¯¯	Subtraction
10	⌐¯¯¯	Logical OR
11	⌐¯¯¯	Logical AND

Fig. for Q. No. 2

The design group provided the alu.v design file for verification.

(a) Write a self-checking test bench in System Verilog where a task named 'result_checker' compare the 'resulted_output' coming from the above DUT (shown in Fig. for Q. No. 2) with the 'expected_output' computed by the 'result_cheker' and any error is reported in the standard output using system command. The operand ***a***, ***b*** and the op code ***s*** are to be generated randomly in the test bench. Show three number of checks in your test bench. **(15)**

(b) Now you are required to build a layered test bench for the above DUT. The proposed interface named alu_if is shown in Fig. for Q. No. 2(b). **(20)**

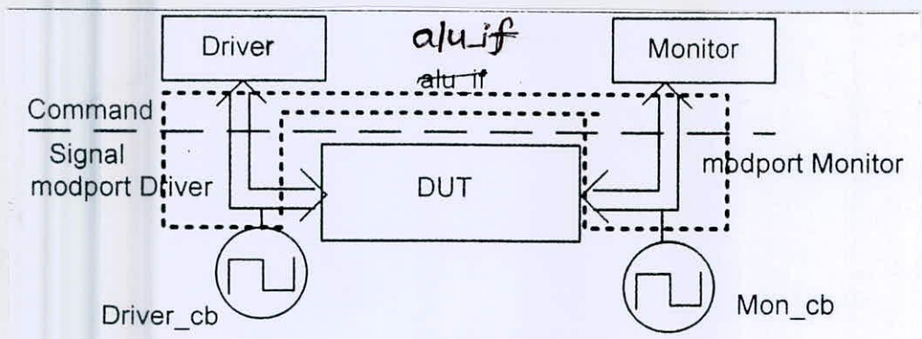


Fig. for Q. No. 2(b)

The Driver object provides the *a*, *b* and *s* data to the DUT and the Monitor object receives the input *a*, *b*, *s* and also the output out from the pin of the DUT. There are two clocking blocks, *Driver_cb* and *Mon_cb* both of which operate at the negative edge of the clock. Here input should be sampled 5ns before negedge clock and output riven after 3ns. Write the System Verilog code of the interface and define Driver and Monitor *modport* inside the interface.

Contd P/3

EEE 467

3. (a) The circuit in Fig. for Q. No. 3(a) shows the source clock pin CLK which supplies clock signal to three different destinations viz. CLKA, CLKB and CLKC. The rise latency and fall latency of each buffer and inverter connected in the path is shown in the figure. All timing parameters are in ns. **(15)**

(i) Calculate the minimum, maximum and average clock latency

(ii) Calculate the clock skew between CLKA, CLKB and CLKC for both rising and falling case of the source clock CLK.

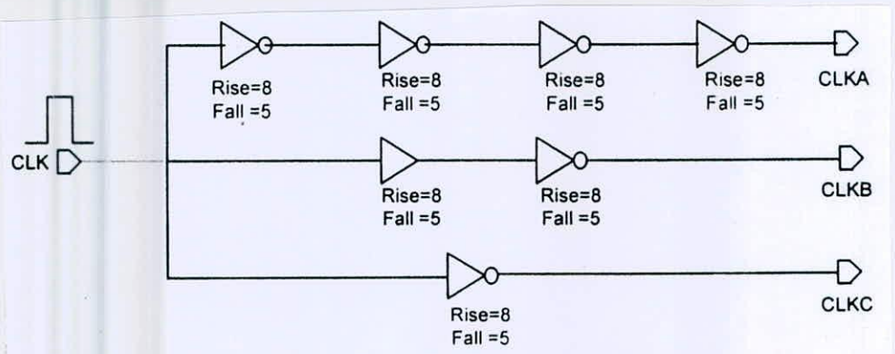


Fig. for Q. No. 3(a)

(b) In the following circuit (Fig. for Q. No. 3(b)), find out whether there is any Setup or Hold Violation? Assume clock 35 ns. **(20)**

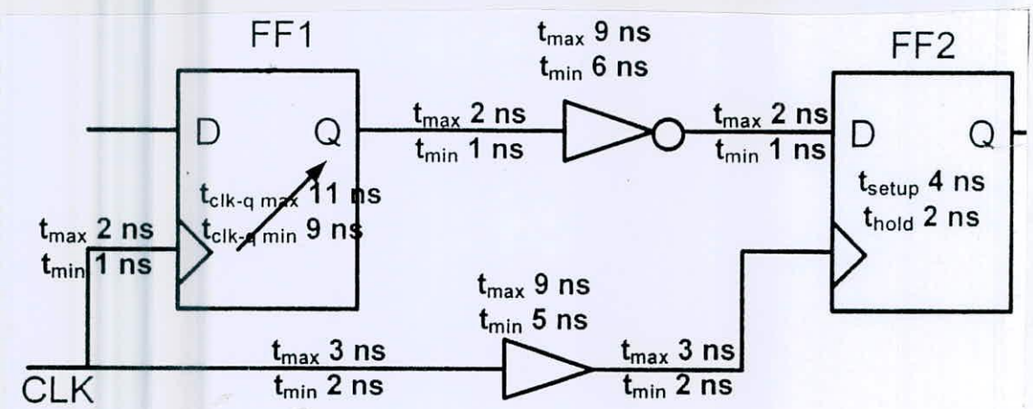


Fig. for Q. No. 3(b)

4. (a) Show the circuit diagram of a 2×2 bit SRAM array clearly showing the I/O bus line, row select, column select, pre-charge and sense amplifier. Explain in details how a data is written and then read to a particular cell of the array. **(12)**

(b) Calculate the number of transistors required to design a 10/1024 row decoder in CMOS technology. How many transistors are required if 2-bit pre-decoding is used? **(10)**

Contd P/4

EEE 467

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

(c) The figure below (Fig. for Q. No. 4(c)) shows a multicycle MIPS microarchitecture. Consider the instruction: Add \$1 \$2 \$3 for which the OPCODE is 000000 and the Funct is 100000. Explain the step by step operation performed by the hardware to implement the above instruction and specifically mention the following: **(13)**

(i) What are the values of control signals generated by the control unit for this instruction?

(ii) Which resources (blocks) perform a useful function for this instruction? Which resources produce no output for this instruction?

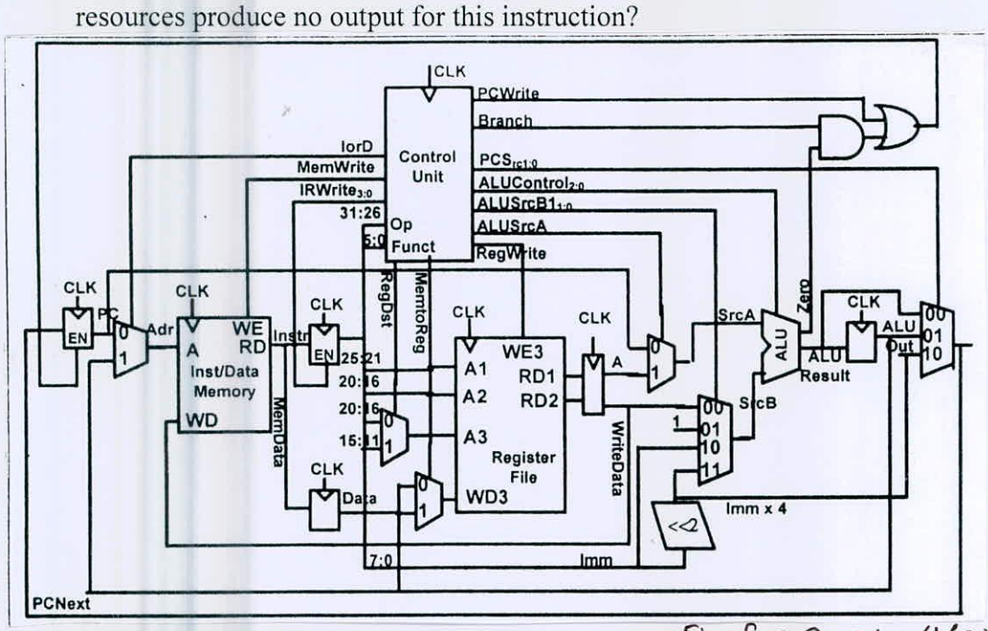


Fig. for Q. No. 4(c)

SECTION – B

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

All the symbols have their usual meanings. Assume reasonable values for missing data.

5. (a) What is noise margin? Why is it necessary for a circuit? **(10)**

(b) (i) Implement a CMOS circuit to obtain the output $F = \overline{AB + CD}$, where A, B, C, D are inputs of the circuit.

(ii) Choose transistor widths to achieve effective rise and fall resistance equal to that of a unit inverter. Assume, $\mu_n = 2\mu_p$.

(iii) Sketch equivalent R-C circuits for worst case falling and worst case rising output transition. Assume there is no sharing or merging of diffusion nodes.

(iv) From the equivalent circuit for rising transition, calculate the propagation delay using Elmore delay model. **(25)**

6. (a) Refer to figure for Q. No. 6(a). Estimate the minimum delay of the path from A to B (shown using dashed line) and choose transistor sizes to achieve this delay. The initial NAND2 gate may present a load of 28λ of transistor width. [For a n input NAND gate, logical effort is (n+2)/3 and parasitic delay is n. For an *n* input NOR gate, logical effort is (2n + 1)/3 and parasitic delay in n.] **(20)**

Contd P/5

EEE 467

Contd. Q. No. 6(a)

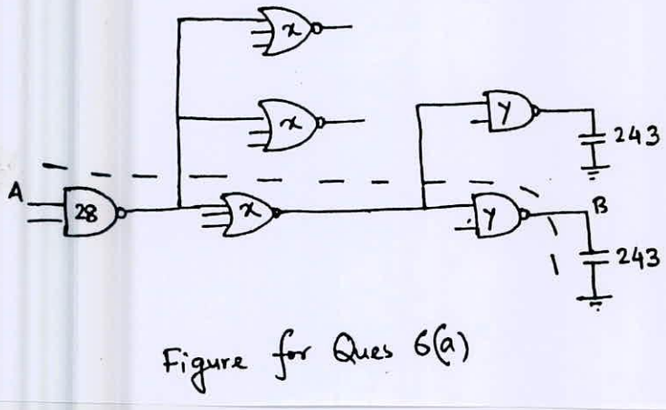


Figure for Ques 6(a)

(b) State and explain some techniques to design fast complex gates. **(15)**

7. (a) Draw a magnitude comparator circuit which can compare two 8 bit numbers. **(12)**

   (b) With necessary diagrams, derive the formulae for maximum and minimum delay constraints and borrow time for a pulsed latch, when there is no clock skew. **(15)**

   (c) Draw the circuit of a flip-flop with asynchronous set and reset. **(8)**

8. (a) Calculate minimum delay of a 128 bit adder for (i) Ripple carry adder, (ii) Carry select adder and (iii) Carry skip adder. Assume delay of a 1 bit full adder is 1 ns and delay of a multiplexer is 2 ns. Which will be the fastest among these three adder implementations? **(17)**

   (b) What is metastability in a sequential circuit? How can this problem be solved? Explain using relevant circuits and diagrams. **(18)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

All the symbols have their usual meanings.

1. (a) Consider elastic collision between two particles of masses m and M. Discuss various aspects of the collision and hence explain why electrons are good ionizers of gas, while ions are not. **(13)**

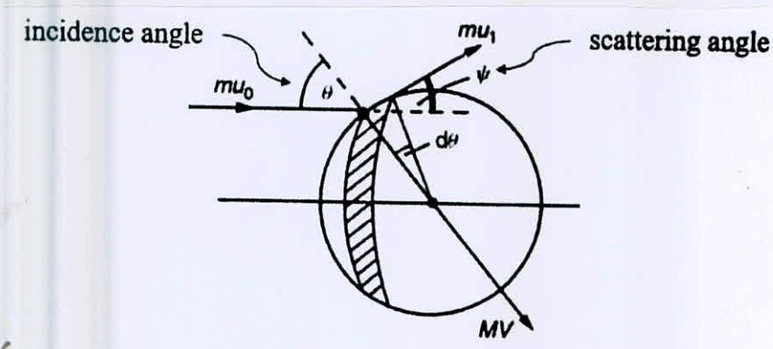


Figure for Q. 1(a)

(b) Cathode play very important role in gas discharges – it supplies electrons for initiation, for sustaining and for completion of a discharge. Discuss various processes that result in release of electron at cathode. **(13)**

(c) The figure below shows the current-voltage relationship in pre-spark region as observed by Townsend. What does i_0 represent? Why the current increase exponentially at higher voltages? **(9)**

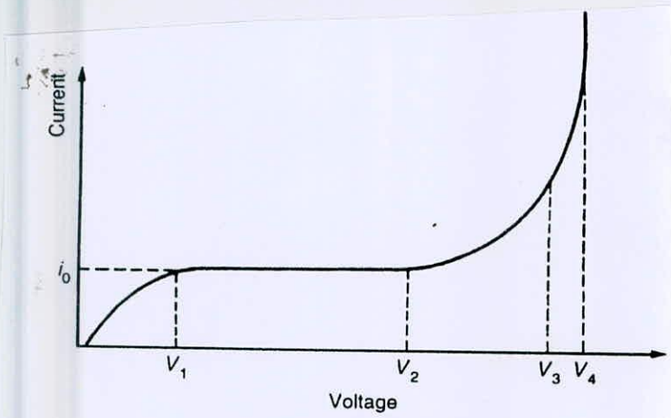


Figure for Q. 1(c)

Contd P/2

EEE 483

2. (a) Electron attachment reduces electron amplification in a gas; gases with a high attachment coefficient such as SF6 have much higher dielectric strength than air. Explain the various deionization by attachment processes in a gas. **(21)**

   (b) The figure below shows the breakdown of a gas on a step-function voltage pulse. Discuss the various quantities V_s, V_p, t_s, t_f. What would be the effect of solar flares on these quantities? **(14)**

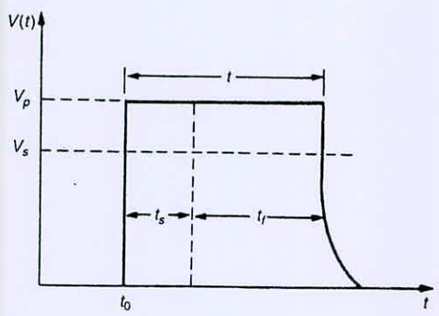


Figure for Q. 2(b)

3. (a) Electrostatic measuring devices can be used for absolute voltage measurements, since the calibration can be made in terms of the fundamental quantities-what are these fundamental quantities? Discuss the working principle of electrostatic voltmeter for high voltage measurement. **(10)**

   (b) Discuss the sources of errors in voltages divider and passive rectifier circuit for a. c. crest voltmeter. Why this circuit cannot be used for impulse voltage measurement? Describe how charge exchange circuit solves the problem. **(18)**

   (c) What are the limitations of various peak voltage measurement methods? **(7)**

4. (a) Behaviour of insulation can be defined by discharge probability as a function of crest voltage $p = p(V)$ - explain. **(12)**

   (b) For the purpose of coordinating electrical stresses with electrical strengths two characteristics are important-overvoltage distribution, insulation breakdown probability. Explain how these are used to describe risk of insulation failure. **(10)**

   (c) Consider the case of a spark gap for which over voltage distribution and insulation breakdown probabilities are shown in figures below. Discuss the relationship between 'statistical safety factor' and 'risk of failure' for the system. **(13)**

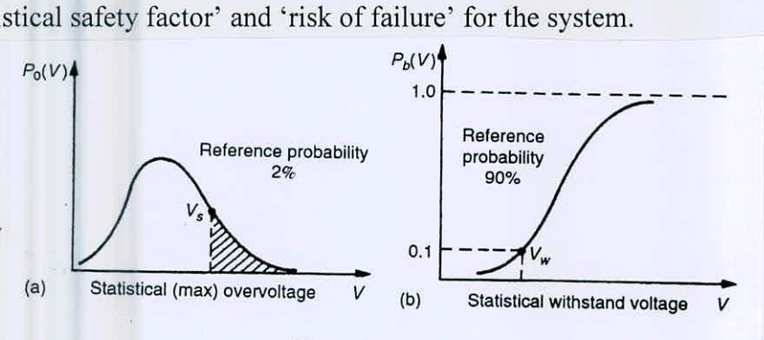


Figure for Q. 4(c)

Contd P/3

EEE 483

SECTION – B

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

5. (a) With a neat diagram, describe the operating principle of any voltage tripler circuit. Derive the expression of a average output voltage and voltage ripple factor. **(15)**

   (b) With a neat diagram, describe the working principle of a variable capacitance generator. Derive the expression of maximum attainable power of a given generator. **(20)**

6. (a) With neat sketches describe the working principle of multistage Marx impulse generator. Also mention the issues involved with construction of spark gaps and layout of generator. **(20)**

   (b) Describe briefly various types of oil-insulated test transformer construction. Also mention their relative advantages and disadvantages. **(15)**

7. (a) Explain thermal breakdown mechanism in solid dielectrics. Elaborate this mechanism when there is a rapid build up of heat i. e. heat lost to surroundings can be neglected. **(14)**

   (b) A solid dielectric specimen of dielectric constant 4.0 shown in Fig. 7(b) has an internal void of thickness 1mm. The specimen is 1 cm thick and is subjected to a voltage of 80 kV (rms). The void is filled with air and the breakdown strength of air can be taken as 30 kV (peak)/cm. **(14)**

   (i) Draw an equivalent circuit of the Fig. 7(b)

   (ii) Find the voltage at which internal discharge can occur.

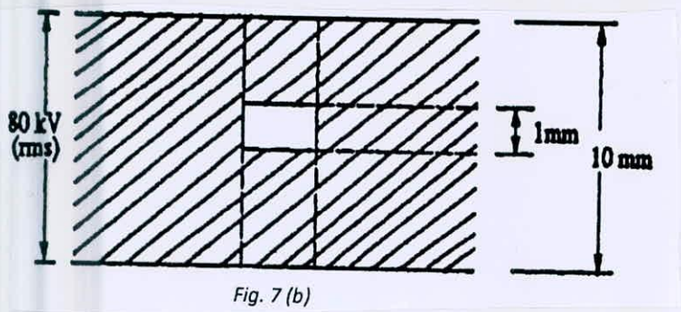


Fig. 7 (b)

   (c) Draw a standard tail chopped lighting impulse showing the instant of chopping. **(7)**

8. (a) What is Static Electrification in transformers? Suggest some solutions of it. **(9)**

   (b) Explain in brief cavity breakdown mechanism for liquid dielectrics. **(10)**

Contd P/4

EEE 483

(c) A series resonant transformer with variable test frequency is shown in Fig. 8(c). Derive the expressions of normalized V, I, f in terms of test object capacitance and also plot them. State some advantages of series resonant circuit. **(16)**

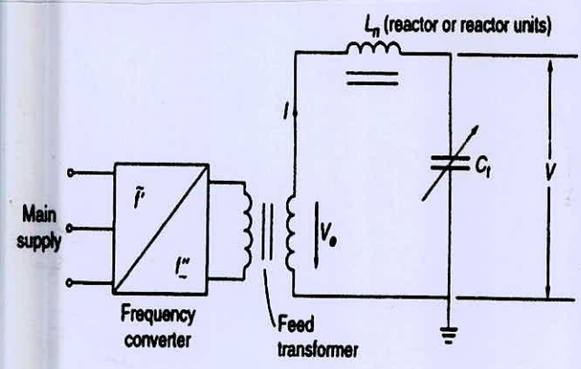


Fig. 8 (c)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc. Engineering Examinations 2020-2021

Sub : **EEE 487** (Nuclear Power 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 and abbreviations have their usual meanings.

1. (a) With necessary illustration and explanation justify the statement "the material (fuel) amount should be critical while the population (number) of neutrons should be subcritical ($k<1$) to sustain a chain reaction in a reactor". **(15)**

   (b) Draw a block diagram showing the nuclear fuel cycle. Discuss the steps of the back end of the fuel cycle. **(20)**

2. (a) Answer the following questions using the labeling (e.g. a zone EFGH) in the Fig. below which shows IAEA Guideline. **(9)**

   (i) In which zones a generator has to run continuously at full output?

   (ii) In which zones a generator may run with reduced output?

   (iii) In which zones a generator may run in short duration emergency with reduced output?

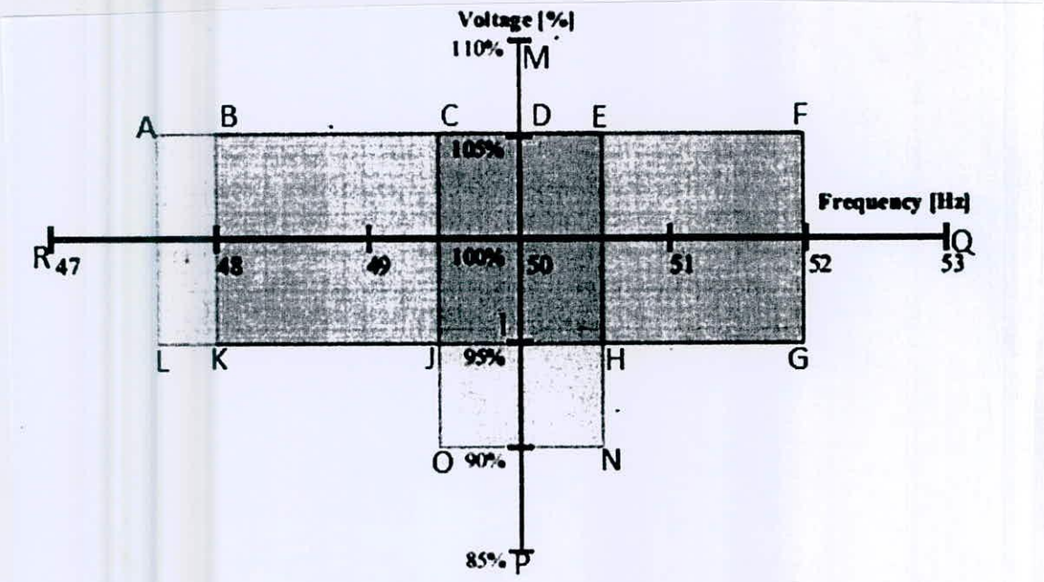


Fig for Q. 2(a)

   (b) When does the following systems feed power to the auxiliaries of an NPP? Which one is labeled class 1E? (i) Grid system, (ii) the NPP, (iii) stand by or safety power supply **(8)**

   (c) Explain in details the necessity of a reliable grid and its characteristics so that a nuclear power plant can be embedded in it. **(18)**

Contd P/2

EEE 487

3. (a) What is Auxiliary Building? **(3)**

   (b) Distinguish between the normal core cooling system and the emergency core cooling systems for an NPP. **(12)**

   (c) Explain the major causes of core melt down. **(20)**

4. (a) Explain International Nuclear Event Scale (INES). **(11)**

   (b) Explain the units curie, gray, sievert, rad, rem, roentgen. **(12)**

   (c) The units both Chernobyl and Fukushima Daiichi NPPs were all BWR type and Generation II reactors. What are the major differences (in terms of root causes and consequences) between the accidents which occurred in these two NPPs? **(12)**

SECTION – B

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

All the symbols have their usual meanings. Assume reasonable values for missing data.

5. (a) Give an overview of global electricity generation from nuclear energy. **(15)**

   (b) A PWR nuclear reactor is composed of 100MTU of 3 w/o fuel. If σ_f = 582.6 barn, thermal *flux*, $\phi = 2.2 \times 10^{13}\ n/(cm^2 - s)$ and w = 190 MeV fission respectively and specific heat of water is 6.06×10^3 J/kg-°C, calculate the mass flow rate of water in the primary water circuit. **(20)**

6. (a) What is the function of steam generators in a PWR type reactor? Explain with necessary diagrams the two variants of steam generators used in PWR. **(15)**

   (b) Discuss the evolution of different generation of nuclear reactors. **(20)**

7. (a) Suppose, there are two proposals for a 1000MWe nuclear power at two different sites. An estimation of various costs and other parameters for these two sites are listed belw: **(17)**

	Site 1	Site 2
Fixed Building Cost, F_B	$ 2 Billion	$1.8 Billion
Annual operating & maintenance cost, O&M	$60 Million/year	$55 Million/year
Capacity Factor, CF	0.92	0.9
Fuel Cost, F_C	$1000/kg	$1025/kg
Thermal Efficiency	0.33	0.33
Fuel Burn-up, B	30,000 MWD/MTU	30,000 MWD/MTU
Levelized fixed charge rate, I	17% /year	17% /year

Which of these proposals will you prefer? Explain with mathematical justifications.

Contd P/3

EEE 487

Contd...Q. No. 7

(b) What are the next generation nuclear reactors? Compare between different types of next gen reactors. **(18)**

8. (a) What is Hydrogen economy? Discuss the role of next gen reactors in hydrogen economy. **(17)**

(b) Write down structural details and functions of fuel rods and control rods used in nuclear reactors. **(18)**

L-4/T-II/EEE **Date : 10/04/2023**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B. Sc Engineering Examinations 2020-2021

Sub : **EEE 489** (Smart Grid)

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

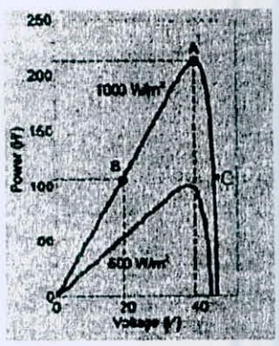
USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

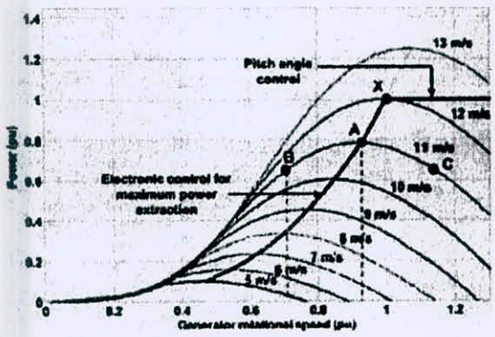
There are **FOUR** questions in this section. Answer any **THREE**.

Symbols and abbreviations have their usual meaning.

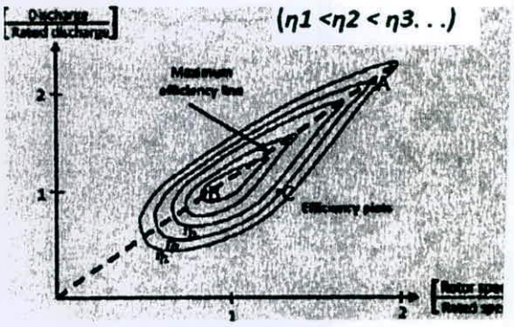
1. (a) Suppose the respective VER (Variable Energy Resonance) generator in each of the following three cases is operating initially at point A. If there is a decrease in the demand or available discharge, the respective VER generator is to be operated **at which point B or C**? **Give logic** for your answer in each case. **(15)**



Power vs. voltage characteristics for a PV gen.



Power vs. rotor speed characteristics for a wind turbine



Flow vs. rotor speed characteristics for a hydro propeller

Fig. for Q. 1(a)

(b) What should be the amplitude modulation index for a PWM inverter that interfaces a PV module with a 230 volts single phase grid so that at the input side of the inverter 350 volts is maintained? **(10)**

(c) If the wind velocity falls will it need to increase or decrease (i) the rotor speed of a grid tied wind turbine and (ii) the frequency modulation index of the grid side VSC converter so that maximum wind power is converted to electrical power? **(10)**

2. (a) Explain the sources of delay in data communication used for a smart grid? **(9)**

(b) How do you compare LEO and GEO satellites for uses in communication between the central server and substation data acquisition devices in relation to protection, monitoring and control in a smart power system? **(10)**

(c) Discuss the prospects and problems of using FOC, PLC, WiMax and ZigBee in smart grid. **(16)**

3. (a) In an area of a distribution utility there are 200,000 consumers provided with smart meters and 1000 data concentrators. Suppose each meter sends 10 bytes of data per second. What should be the data transfer rate of each link between the concentrators and the server? **(8)**

Contd P/2

EEE 489

Contd...Q. No. 3

(b) Discuss applications of dedicated and shared communication channels in a smart grid. **(12)**

(c) What is protocol? Discuss how the "Network Layer" of a protocol functions for data transfer involving packet switching and multiple communication networks. **(15)**

4 (a) Explain the concept of grid hardening. **(15)**

(b) Explain the concept of "Internet of Energy (IoE)". **(20)**

SECTION – B

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

All the symbols have their usual meanings. Assume reasonable values for missing data.

5. (a) Compare Traditional grid and smart grid from the perspective of generation, transmission, distribution and control. **(12)**

(b) Explain briefly how the variable output by the renewable sources can be compensated? **(8)**

(c) Describe the various schemes for price-based and incentive-based DSI implementations. **(15)**

6. (a) Write down the basic differences between HAN and IoT. **(5)**

(b) Discuss the steps taken so far towards implementing smart grid in Bangladesh. **(10)**

(c) With a block diagram, describe the hierarchical control and islanded mode operation of a typical micro grid. **(20)**

7. (a) Describe briefly the motives behind implementing smart grid in modern power system. **(15)**

(b) With block diagram, illustrate different types of interfaces between HAN and NAN to provide demand management functions and demand response. **(8)**

(c) Describe the construction and application of NaS, Li-ion and NiCd batteries. Also, Write down the names of different types of Non-electrical Energy Storage Systems with their application. **(9+3)**

8. (a) What is DSI? Give a description of hardware accessories used to implement DSI. How DSI provide frequency support a system in the event of frequency excursion? **(2+10+5)**

(b) Consider the circuit shown in Fig. 1. for Q. 8(a). The generation end transformer is rated for 132/33 kV. The distribution side transformer is rated for 33/11kV with an on-load tap changer which maintains the load voltage at 11 kV.

Contd P/3

EEE 489

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

The transmission line is 10 km long and has an impedance $1.12\angle 63.43°$ Ω/km. The motor load is always running at 0.9 power factor, but at different time on a day, the absorbed power by the load varies as shown in Fig. 2. For Q. 8(a).

(i) Calculate the percentage reduction in energy loss in the 33 kV line if load shifting shown in the Fig. 2. For Q. 8(a) is managed. Ignore the 33 kV//11 kV transformer losses. **(12)**

(ii) If it is possible to maintain always a constant load level keeping total energy consumption constant, what will be the line loss then? **(6)**

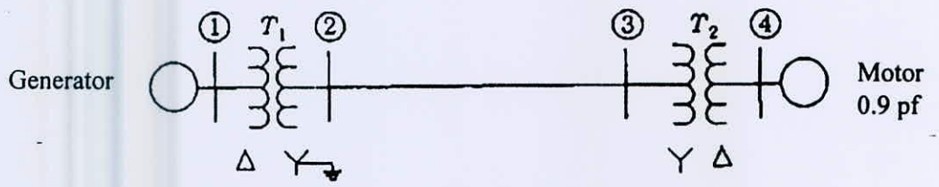
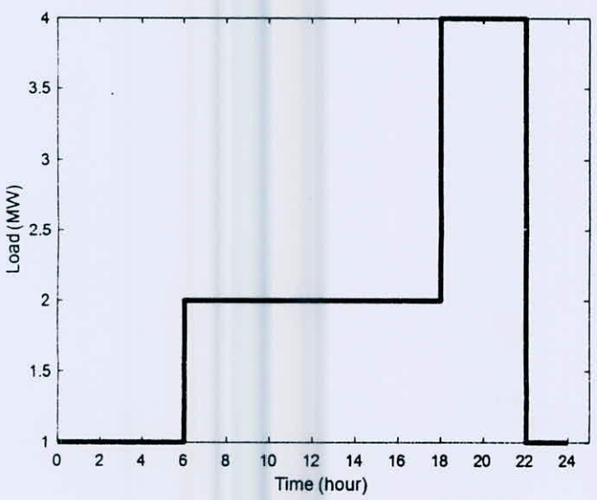
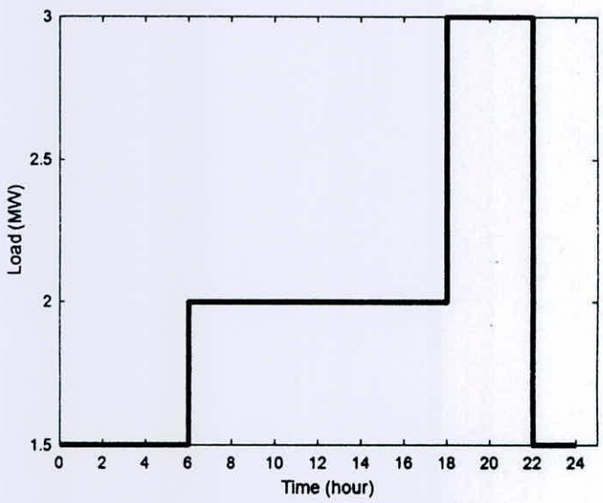


Fig1. for Q. 8(a)



Normal load curve



Scenario after load shifting

Fig2. for Q. 8(a)
