L-4/T-2/EEE **Date: 09/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

Sub: **EEE 371** (Power System II)

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 3 page(s) in this question paper.

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) Show that the transmission loss equation of a power system having K number of generators can be expressed by the following equation. (20)

$$P_L = \sum_{i=1}^{K}\sum_{j=1}^{K} P_{gi} B_{ij} P_{gj} + \sum_{i=1}^{K} B_{i0} P_{gi} + B_{00}$$

(b) The incremental fuel costs (in \$/MWhr) for a plant consisting of two units are given by: $\lambda_1 = (0.008P_{g1}+8)$ and $\lambda_2 = (0.0096P_{g2}+6.40)$. 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 with the following distribution of the load: unit-1: 500 MW and unit-2: 400 MW. (10)

2. (a) Show that the Fast Voltage Stability Index (FVSI) of k-th bus can be expressed by the following relation. (15)

$$FVSI_k = \frac{4Z^2 Q_k}{V_S^{\,2} X}$$

(b) (i) What is voltage sag? How is it calculated due to a fault? (15)

(ii) Explain the design principle of a single tuned passive filter for harmonics mitigation.

3. (a) Define the commonly used performance metrics of frequency response. Explain the role of governor response and under frequency load shedding in the context of frequency response adequacy. (15)

(b) How does load frequency relief (k_p) contribute to frequency stability? Formulate a general expression of k_p from the following exponential load model. (15)

$$P = P_0\left(\frac{V}{V_0}\right)^{np1} \times \left(1 + k_p \times \frac{\Delta f}{f_0}\right)$$

4. (a) Briefly explain the working principle of a STATCOM and a UPFC. (15)

(b) A ± 30 MVAR SVC is delta connected to 132 kV system via a 132/6 kV transformer. The SVC consists of a 12-pulse TCR and two switched capacitor arms, one tuned to the 11th harmonic and the other tuned to the 13th harmonic (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 branches. (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) Define power system stability. Show the classification of power system stability using a tree diagram. (10)

(b) Derive the general expressions of power and torque of a salient pole machine considering two-axis model. (20)

6. (a) Derive the following relation which governs the rotational dynamics of a synchronous machine in power system stability. (15)

$$\frac{2H}{\omega_s}\frac{d\omega}{dt} = P_m - P_e \text{ per unit}$$

(b) With necessary diagrams, explain the equal-area criterion for a typical single machine infinite bus system when a fault occurs at the sending end bus. (15)

7. (a) Derive a linear 2nd order differential equation governing the incremental variations in rotor angle and output power of a synchronous machine when the mechanical input power is fixed. (15)

(b) The single-line diagram of figure given below shows a generator connected through parallel transmission lines to an infinite bus. The machine is delivering 1.0 per unit power and both the terminal and infinite-bus voltages are 1.0 per unit. Numbers on the diagram indicate the values of reactances on a common system base. The transient reactance of the generator is 0.2 per unit as indicated. Calculate the value of synchronizing power coefficient when the machine is operating at $\delta = 28.44^{o}$ and is subjected to a slight temporary electrical system disturbance (15)

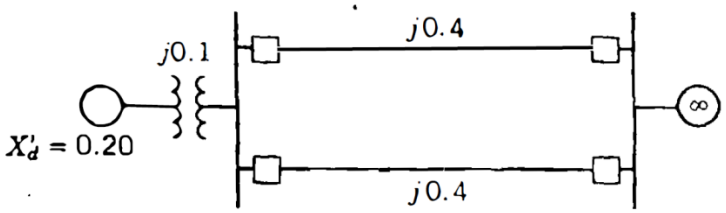

Figure for Q.7(b)

8. (a) Explain the factors which affect the transient stability of a power system. (10)

(b) Describe the step-by-step solution procedures of swing equations for a multi-machine power system. (20)

L-4/T-2/EEE **Date: 19/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examination 2018-19

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

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

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

There are 4 page(s) in this question paper.

SECTION – A

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

1. (a) Sketch the action potentials corresponding to five major portions of the heart during a cardiac cycle and also sketch the resulting ECG generated from those five action potentials (maintain a relative time scale). (18)

(b) Find the heart rate, PR interval, and QRS duration in the first ECG waveshapes shown below in Fig 1 (b). State the possible type of disease and mention etiology. (12)

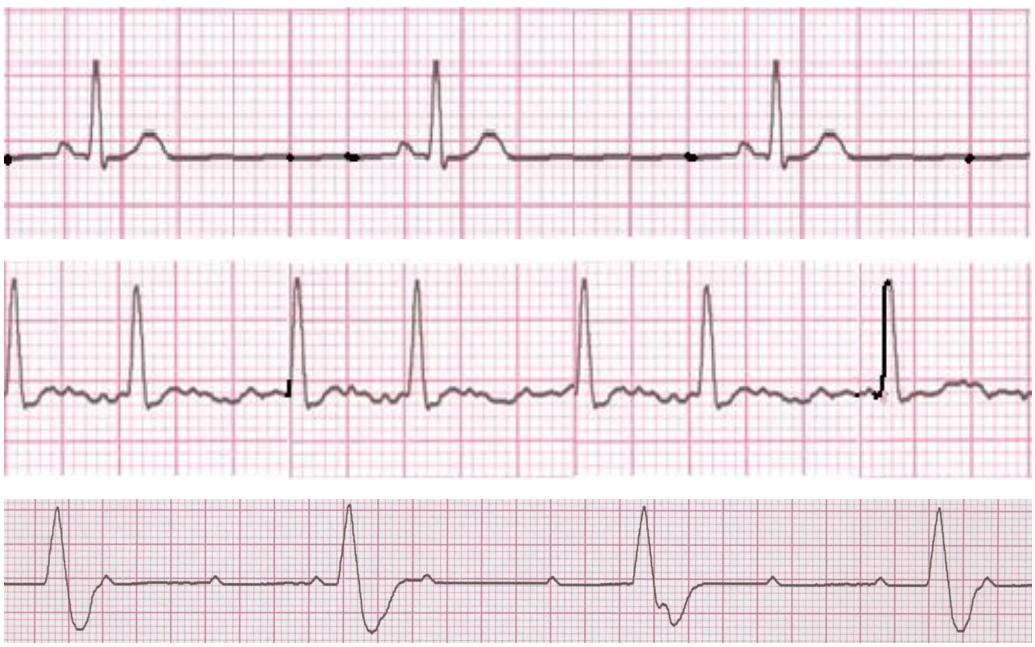

Fig 1 (b)

2. (a) From the following two ECG lead plots in Fig 2 (a) (i) and Fig 2 (a) (ii), find whether the person corresponding to each plot is having a myocardial infraction. If so, where? (18)

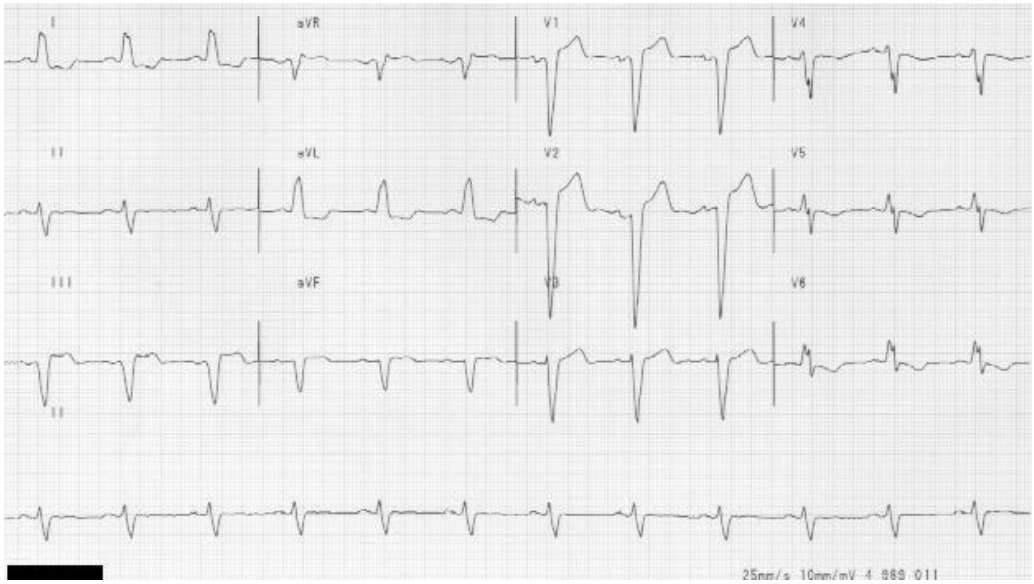

Fig 2 (a) (i)

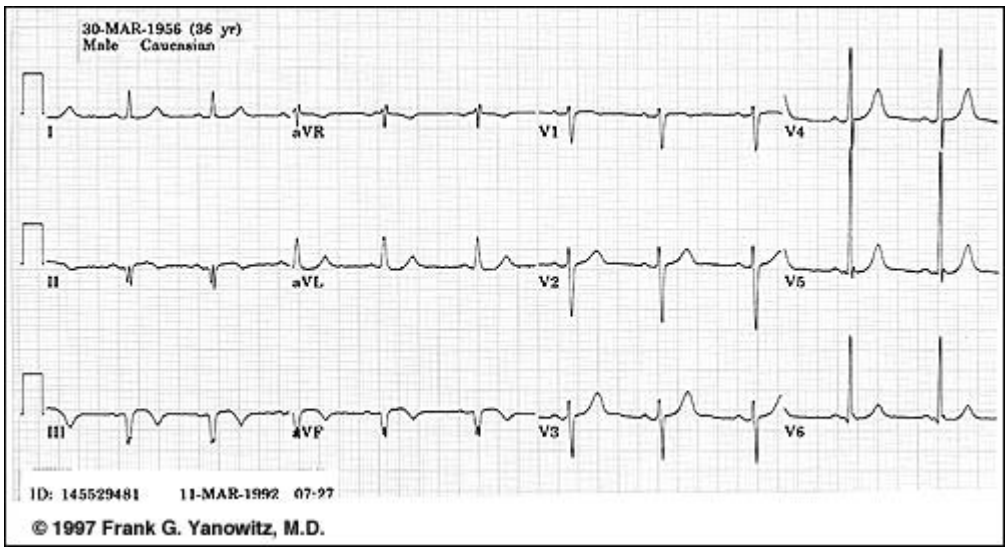

Fig 2 (a) (ii)

(b) From the following ECG lead plot in Fig 2 (b), mention the name of the change seen and comment on what change is manifested compared to the (12)

normal rhythm, under which leads and which location or area of the heart.

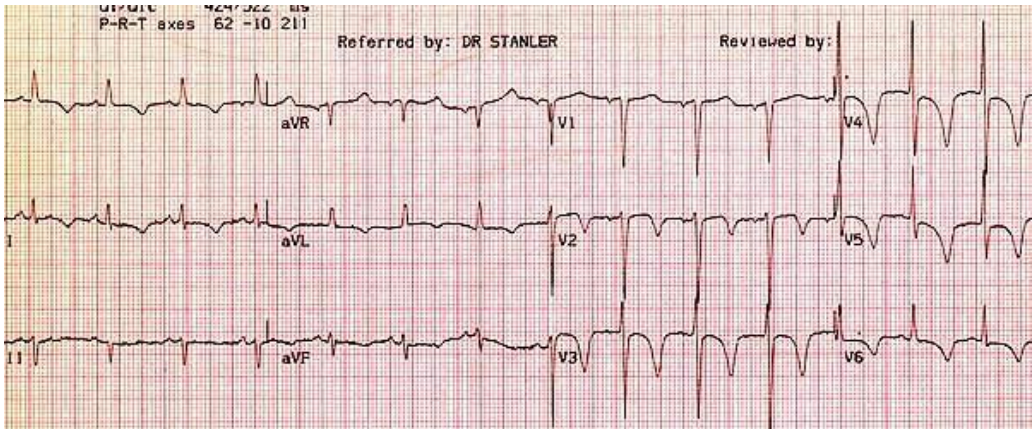

Fig 2 (b)

3. (a) Define defibrillator. Compare different kind of defibrillators. (10)

(b) From the following Fig 3 (b) of Sphygmomanometer cuff, mention the relation between cuff pressure and blood flow in each stage. (20)

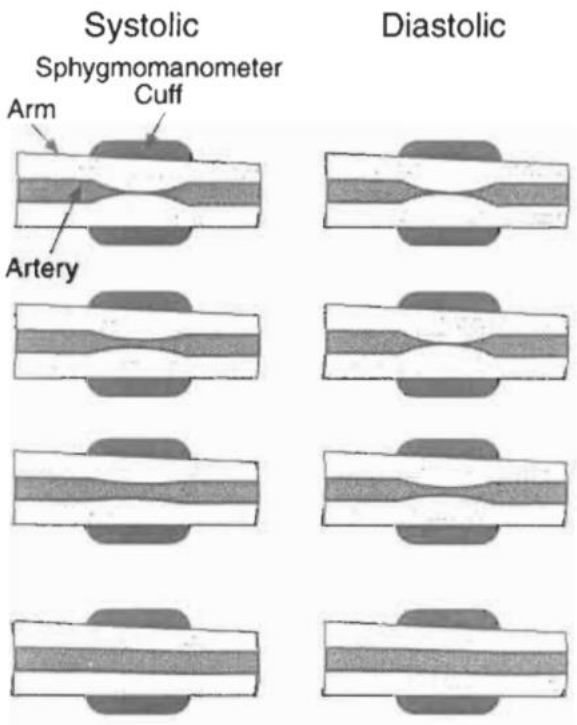

Fig 3 (b)

4 (a) Explain the difference between ERP and EGG? Compare between isomorphic and metamorphic seizure patterns. 10

(b) Draw the block diagram of the atrial synchronization pacemaker. While explaining the working principle of atrial synchronization pacemaker, mention its difference from demand mode pacemaker. 20

SECTION – B

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

5. (a) The recorded ECG signal shown below is affected by noise. Identify the type of noise. In general filtering may reduce the effect of this noise. Briefly discuss the effect of different types of filtering with possible outcome. (15)

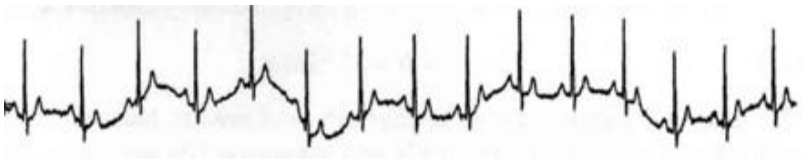

Fig. for Q. 5(a)

(b) With neat sketch, compare the functions of colorimeter, flame photometer and spectrophotometer. (15)

6. (a) Compare, with equivalent circuits, resistive, inductive, capacitive and piezoelectric transducers. (15)

(b) Draw the equivalent circuit of the body surface electrode. Compare the working principles of different body surface recording electrodes. (15)

7. (a) With sketch, mention why a collimator is installed in an X-ray machine? Mention the interpretation of strong blackening and weak blackening in X-ray image. These are manifested in which issues? (15)

(b) Compare the principles of X-ray, CT and Ultrasound imaging. Write interpretation of different scanning modes of ultrasound imaging. (15)

.

8. (a) Mention applications of scintigraphy in lung, renal, brain and thyroid problem diagnosis. (15)

(b) Compare static and dynamic imaging techniques (SPECT, PET). Show with diagram the function of the gamma camera (from the patient to the image). (15)

L-4/T-2/EEE **Date: 09/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

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

Full Marks: 180 Time 2 Hours

The Figures in the right margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 2 (TWO) pages in this question paper.

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) Explain the two criteria used for ST code design. (15)

   (b) Summarize the advantages and disadvantages of OSTBCs. Explain one OSTBC and show why it is called an orthogonal code. (15)

2. (a) What is the desired auto-correlation property of a PN code? Compare *m*-sequence and Gold sequence in terms of auto-correlation property. (12)

   (b) Consider a 3-stage *m*-sequence generator having a characteristic polynomial $(1 + x + x^2)$. If the initial seed is 001, determine the *m*-sequence. Also, write the *m*-sequences if 010, 100, 110 and 111 are used as seeds. (18)

3. (a) Explain the operation of an MC-DS-CDMA transmitter. (10)

   (b) Find the channel capacity for the channel having the following transition matrix: (20)

$$P(Y \mid X) = \begin{bmatrix} 0.7 & 0.3 \\ 0.1 & 0.9 \end{bmatrix}$$

4 (a) Write short notes on - (i) LTE frame structure, and (ii) transport block formation in LTE data/user plane. (16)

   (b) Consider a flat-fading channel with i.i.d. channel gain g_i, which can take on three possible values: $g_1 = 0.05$ with probability $p_1 = 0.1$, $g_2 = 0.5$ with probability $p_2 = 0.5$, and $g_3 = 1$ with probability $p_3 = 0.4$. The transmit power is 10 mW, the noise power spectral density is $N_0 = 10^{-9}$ W/Hz, and the channel bandwidth is 30 KHz. Assume that both the transmitter and the receiver have the knowledge of the instantaneous value of g_i. Find the ergodic capacity of this channel considering adaptive power allocation using Water-filling algorithm. (14)

SECTION – B

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

All the symbols have their usual meanings.

5. (a) Discuss the factors that affect the small-scale fading and large-scale fading. Also, briefly mention the techniques used to overcome the effects of large-scale fading and small-scale fading on the performance of wireless communication. (15)

(b) A base station is transmitting 20W using a carrier frequency of 2.1 GHz having bandwidth of 180 kHz. Antenna heights at the base station and the mobile station are 25m and 2.5m, respectively. Antenna gains of the base station and mobile station are 8 dB and 0 dB, respectively. The mobile station requires a minimum SNR of 30 dB for proper communication. Calculate the (i) cell radius, (ii) coverage area, and (iii) the data rate at a mobile station located at the cell edge, assuming 2-ray ground reflection path-loss model. (15)

6. (a) Define the average probability of symbol error for a fading channel. Then derive the expression of average bit error rate for BPSK modulation considering a Rayleigh fading channel. (15)

(b) Consider a communication system with M diversity branches, where instantaneous SNR of each diversity branch is exponentially distributed with parameter 0.04. Determine which diversity combining technique out of SC, MRC and EGC performs the best in this channel. (15)

7. (a) Distinguish the signal models of MISO channel and MIMO channel. (10)

(b) When does the Water-filling algorithm become useful in MIMO communication system? Explain the operation of the algorithm in such scenario. (20)

8. (a) Explain the difference between the coding gain and diversity gain. (10)

(b) Prove that without using pre-processing, transmit antenna diversity (MISO) does not provide any diversity gain. Then show that Alamouti scheme based pre-processing scheme in MISO system provides full diversity gain. Assume that the channel is unknown to the transmitter. (20)

L-4/T-2/EEE **Date: 12/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

Sub: **EEE 443** (Radar and Satellite Communications)

Full Marks: 180 Time 2 Hours

The Figures in the right margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 4 pages in this question paper.

SECTION – A

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

Answer in **brief** and **to the point**. All the symbols have their usual meanings.

1. (a) What is a satellite? Define a satellite orbit and its inclination angle. Compare and contrast the uplink and downlink frequencies of satellite communication with mobile cellular communication. **(7+8)**

   Draw the block diagram of an FDM-TDM/PCM converter used in a digital earth station to serve the terrestrial analog FDM customers and explain its operation in brief.

   (b) Mention the two unique features of satellite communication. Draw the block diagram of a typical satellite repeater/transponder and mention the basic functions of each block. **(7+8)**

   An earth station, operating at 12 GHz with a 10° elevation angle has a 47-dB gain and 2.5 dB loss from the antenna feed to the input of the LNA. The sky noise is 25° K developing an antenna noise temperature of 240° K. The noise figure of the LNA is 1.5 dB. Calculate the G/T.

2. (a) With neat sketches, name and describe the use of the 4 types of satellite antenna. Mention the special advantage of a phased-array antenna. **(8+7)**

   Draw the simplified diagram of the communication system carried by a typical Intelsat satellite and mention the function of the switch matrix in it.

   (b) Name the two types of earth-station antenna. With a neat sketch, describe the functions of each part of **any one** of them. **(9+6)**

   What is a VSAT? With a neat sketch, describe its basic operation in brief. Enumerate the applications of mobile satellite communications.

3. (a) Explain the terms "FDM-FM-FDMA", "TDM-PSK-TDMA" and "TDM-SCPC-FDMA" with reference to satellite communication. **(9+6)**

How can we increase the transponder bandwidth using SDMA/frequency reuse?

(b) A LEO satellite communication system uses direct sequence CDMA as the multiple access method for groups of terminals within each of its multiple antenna beams. The terminals generate and receive compressed digital voice signals with a bit rate of 9.6 kbps. The signals are transmitted and received at a chip rate of 5.0Mbps as BPSK modulated DSSS-CDMA. In the absence of any other CDMA signals, the input power level at the receiver input is −116.0dBm (−146.0dBW) for one CDMA signal, and the noise temperature of the receiving system is 300°K. The satellite transmits 31 simultaneous CDMA signals. **(8+7)**

(i) Find the SNR for the 9.6 kbps BPSK signal after despreading, and estimate the BER of the data signal, given a system implementation margin of 1dB.

(ii) If two of the multiple beams from the satellite overlap, so that a second group of 31 DS-SS CDMA signals is present at the receiver, find the BER of the desired signal.

4. (a) Show a simplified diagram of a generic TDMA frame and mention how its contents are used for synchronization between the earth stations and satellites in a network. **(8+7)**

With neat diagrams, show the star and mesh configurations of satellite networks, and mention the basic functional differences between the two.

(b) Enumerate the satellite communication link design steps. Write down the link equation from an earth station to a satellite and show its components in a neat diagram. **(8+7)**

Using the uplink noise power budget given in Table 1, first calculate the required power at the transponder input, P_r (dBW), to meet the requirement of $(C/N)_{up}$=30dB. Finally, referring to the uplink power budget shown in Table 2, calculate the uplink (earth station) transmitter power both in *dB* and *watt*. Is it a realistic transmitter power? If not, suggest how it can be practically realized.

Table 1: Noise Power Budget (Uplink)

Boltzmann's constant , 1.38 x10^{-23} J/°K	k	–228.6 dBW/K/Hz
Transponder noise Temperature, 500°K	T_S	27.0 dBK
Receiver noise bandwidth, 43.2MHz	$B=B_n$	76.4 dBHz
Noise power in the transponder	$N=P_n$	–125.2 dW

Table 2: Uplink (Carrier) Power Budget

Earth station transmitter power	P_t	P_t dBW
Earth station antenna gain	G_t	55.72 dB
Satellite receiving antenna gain	G_r	31.0 dB
Free space path loss	L_p	–207.17 dB
Earth station on –2dB contour	L_{ant}	–2.0 dB
Atmospheric path loss	L_{up}	–0.7 dB
Miscellaneous path loss	L_{misc}	–0.3 dB
Received power at transponder input	P_r	P_t –123.45 dBW

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 does a GPS transmitter transmit? How does it identify itself? **(08)**

(b) Explain the method of detecting position on or above the earth with the help of a GPS Receiver. Include the necessary calculations for ideal conditions. **(22)**

What are the major sources of errors in position calculations and the remedial measures?

6. (a) Elaborate the term RADAR. What do you understand by *range* of a RADAR? State five principal applications of RADAR. **(10)**

(b) Answer the following questions: **(10)**

i) State the frequency band commonly used for fire control and imaging.

ii) What is continuous wave RADAR?

iii) What is the most common waveform transmitted from a RADAR transmitter?

iv) Distinguish between mono- and bi-static RADAR.

v) Write down the equation to measure RADAR range using the time taken by the pulse to travel to the target and return. What is the maximum unambiguous range?

(c) State intuitively with the help of diagram(s), why coherent integration strengthens the backscattered signal but suppresses noise. **(10)**

What is the role of a matched filter in achieving high range-resolution in RADARs?

7. (a) With the help of a block diagram, briefly describe each major component of a modern RADAR system. **(15)**

(b) Answer the following questions related to RADAR: **(09)**

i) Other than doppler frequency shift method, name one method that can be employed to determine the relative velocity of the target.

ii) In order to determine the shape of the target, what technique can be employed? Name the type of RADAR that performs shape reconstruction.

iii) *Radio waves of HF band are refracted/reflected back to ground by the ionosphere* – mention one RADAR application of this phenomenon.

(c) For a RADAR system, the scattering matrix of the backscatterer is, **(06)**

$$S = \begin{bmatrix} 0.4 & 0.5 - j0.1 \\ 0.5 - j0.1 & 0.5 + j0.3 \end{bmatrix}.$$

Comment on the RADAR system on why it is single-polarized or fully polarized.

8. (a) In **SAR** RADARs, how does a single antenna *synthesize* a large aperture? Explain briefly. **(10)**

(b) What is measured by the parameter RCS? **(05)**

(c) A directive antenna with a gain of 6dB (with respect to an isotropic radiator) at a particular direction transmits a power of 10 Watts at the operating frequency of 1 GHz. Calculate the power density at a point 1 km away from the antenna in the same direction. Now, if an airplane with an RCS value of 2 m^2 appears at that point, calculate the power of the reflected signal at that position. Also, calculate the power density of the reflected signal at the position of the RADAR. Assume monostatic scenario. **(15)**

---------- 0 ----------

L-4/T-2/EEE **Date: 23/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

Sub: **EEE 447** (Introduction to Digital Image Processing)

Full Marks: 180 Time 2 Hours

The figures in the margin indicate full marks. All the symbols have their usual meanings.

Assume reasonable values for missing data.

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 4 page(s) in this question paper.

SECTION – A

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

1. (a) The white bars in the test pattern shown are 5 pixels in width and 80 pixels in height. The separation between the bars is 10 pixels. Sketch the look of the image after the application of a 5×5 median filter. **(7)**

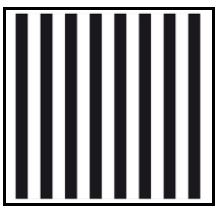

Fig. for Q.1(a)

(b) Let an 8-bit image $f(x,y) = \delta(x,y)$ be blurred by uniform motion $x(t) = \frac{at}{T}$ and $y(t) = \frac{bt}{T}$, where a and b are non-negative scalars, and T is the time of camera exposure. Design a Wiener filter for deblurring the degraded image. Assume that white noise of variance 10 is added during the imaging condition. **(23)**

2. (a) Sketch the Radon transform of the following square image. Assume a parallel-beam geometry. **(7)**

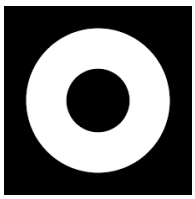

Fig. for Q. 2(a)

(b) Show that the Radon transform of the following Gaussian shaped 2D **(23)**

function

$$f(x,y) = (x^2 + y^2)\exp(-x^2 - y^2)$$

is given by

$$g(\rho,\theta) = \frac{\sqrt{\pi}}{2}(2\rho^2 + 1)\exp(-\rho^2)$$

3. (a) Compute the Haar wavelet transform of a 2×2 image given by **(15)**

$$\boldsymbol{F} = \begin{bmatrix} 105 & 35 \\ 33 & 107 \end{bmatrix}$$

(b) The inverse Haar transform is $\boldsymbol{F} = \boldsymbol{H^T W H}$, where $\boldsymbol{W}$ is the Haar wavelet transform of the image and $\boldsymbol{H^T}$ is the matrix inverse of $\boldsymbol{H}$. Show that the relation $\boldsymbol{H_2^{-1} = H_2^T}$ exists and use it for computation of the inverse Haar wavelet transform of the result found in (a) **(15)**

4. Consider the simple 4 × 8, 8-bit image: **(30)**

21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243
21	21	21	95	169	243	243	243

(i) Compute the entropy of the image considering the row-wise pairs of pixels.

(ii) Compress the image using the Huffman coding by considering the pairs of pixels. Explain the result of compression.

(iii) Compress the image using LZW coding. Show details of the code words and dictionary locations.

(iv) Compare the Huffman and LZW coding schemes with the results obtained.

SECTION – B

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

5. (a) What are the basic components of a general-purpose image processing system? Briefly describe each component with necessary block diagram. **(20)**

(b) A common measure of transmission for digital data is the baud rate, defined as the number of bits transmitted per second. Generally, transmission is accomplished in packets consisting of a start bit, a byte (8 bits) of information, and a stop bit. Using these facts, answer the following: (i) How many minutes would it take to transmit a 1024 × 1024 image with 256 intensity levels using a 56K baud modem? (ii) What would the time be at 3000K baud, a representative medium speed of a phone DSL (Digital Subscriber Line) connection? **(10)**

6. (a) Prove that both the 2-D continuous and discrete Fourier transforms are linear operations. **(20)**

(b) A camera is equipped with a 35 mm lens. The CCD camera chip of dimensions 7 × 7 mm and having 1024 × 1024 elements, is focused on a square, flat area, located 0.5 m away. How many line pairs per mm will this camera be able to resolve? **(10)**

7. (a) Show that 2-D transforms with separable, symmetric kernels can be computed by (i) computing 1-D transforms along the individual rows (columns) of the input, followed by (ii) computing 1-D transforms along the columns (rows) of the result from step (i). **(15)**

(b) An image with intensities in the range [0, 1] has the PDF $p_r(r)$ shown in Fig. for 7(b). It is desired to transform the intensity levels of this image so that they will have the specified $p_z(z)$ as shown. Assume continuous quantities and find the transformation (in terms of r and z) that will accomplish this. **(15)**

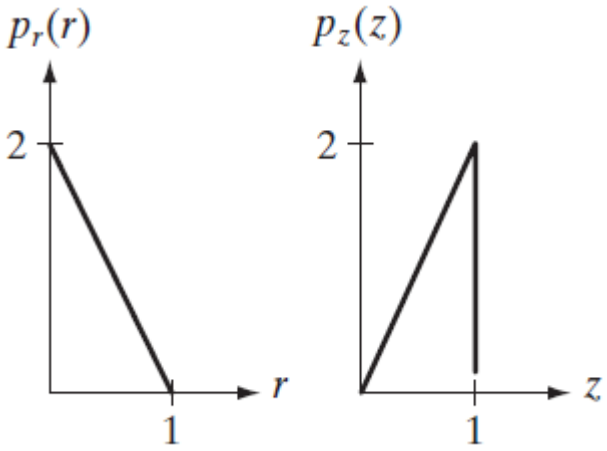

Fig. for Q. 7(b)

8. (a) Consider a 3 × 3 spatial mask that averages the four closest neighbors of a point *(x,y)*, but excludes the point itself from the average. Find the equivalent filter *H(u,v)* in the frequency domain and show that *H(u,v)* is a low pass filter. **(15)**

(b) The two images in Fig. for 8(b) are quite different, but their histograms are the same. Suppose that each image is blurred with a 3 × 3 averaging mask. Explain whether the histograms of the blurred images would be equal. If your answer is *no*, sketch the two histograms. **(15)**

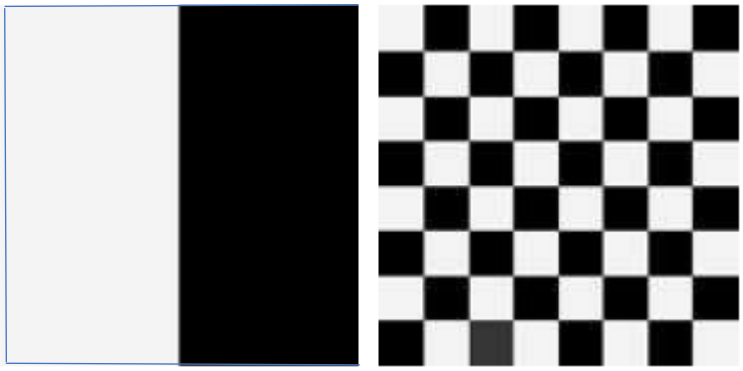

Fig. for Q. 8(b)

L-4/T-2/EEE **Date: 12/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

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

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 2 pages in this question paper.

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) Briefly discuss the various technologies used to fabricate plasmonic devices. What is a HEPA filter and how does it help in a cleanroom? (10+5)

   (b) How does chemical mechanical polishing (CMP) help improve wafer quality? What are the differences between CZ and Float Zone methods of wafer fabrication? (8+7)

2. (a) Draw the process sequence diagram (sequential processes) involved in "Phosphoric Oxide Deposition and Cap Oxidation". (12)

   (b) Explain vapor phase growth steps in terms of gas phase decomposition, adsorption, surface diffusion. (18)

3. (a) Describe ion implantation technique with a proper diagram. (20)

   (b) Describe the operation of Molecular Beam Epitaxy. (10)

4. (a) Why is plasma etching preferred in some applications over wet etching? How does LPCVD differ from APCVD? (5+5)

   (b) Explain the Deal-Grove model of oxidation in detail. (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) Why silicides are used for ohmic contacts? Compare them with copper for metal contacts. (15)

   (b) Discuss the functions of IC packaging. (15)

6. (a) Discuss potential hazards from cleanroom pollutants. (15)

   (b) Discuss the necessity of hard bake during ten-step process. (15)

7. (a) What are the two types of photoresists? Discuss their differences and chemical compositions. (15)

   (b) What are the aligner selection criteria? Discuss the differences between contact aligner and proximity aligner. (6+9)

8. Write short notes on - (30)

   (a) Dry oxidation

   (b) Extreme Ultraviolet Lithography

   (c) Two color pyrometry

L-4/T-2/EEE **Date: 09/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B.Sc. Engineering Examination 2018-19

Sub: **EEE 457** (VLSI Circuits and Design II)

Full Marks: 180 Time 2 Hours

The figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 4 page(s) in this question paper

SECTION – A

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

All the symbols have their usual meaning

Assume reasonable values for missing data

1. (a) Discuss the difference between device scaling and interconnect scaling in terms of delay parameters. In a 1 um CMOS process, W_n/L_n=10 um/1 um, W_p/L_p=20 um/1 um, t_{gox}=30 nm, ε_{ox}=0.35 pF/cm, C_{int}=2 pF/cm. Calculate the interconnect length at which interconnect capacitance becomes comparable with gate capacitance. (20)

   (b) Is the current density of devices affected by CMOS scaling trends? Explain your answer using the Dennard principle. (10)

2. (a) Design a four-input NOR gate with transistor widths chosen to achieve effective rise and fall resistance equal to that of a unit inverter. Then sketch equivalent circuits for falling and rising output transitions and estimate the gate's worst-case propagation delay if the output is loaded with *h* identical gates like itself. Use appropriate delay models. (20)

   (b) Explain how high-k dielectric can assist the progression of CMOS technology. (10)

3. (a) Using basic delay models, estimate the frequency of a 15-stage ring oscillator. Assume it uses a 0.6 um process with τ = 60 ps. (12)

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

4 (a) Explain the relative merits and limitations of cascode voltage switch logic over other circuit families. (10)

(b) Write short notes on the following topics related to a CMOS process flow: ILD-1, STI, Tungsten Plug. (20)

SECTION – B

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

All the symbols have their usual meaning

Assume reasonable values for missing data

5. (a) A 32 bit adder have to be designed using carry select approach. Delay of the one bit adder circuit is 2 nsec and the delay of the multiplexer is 1 nsec. Determine the optimum block size and number of adders in each block. Draw the schematic diagram of the second block. (15)

(b) Sketch the partial products used by a radix-4 Booth-encoded multiplier to compute $(18)_{10} \times (12)_{10}$ and show the generation of the corresponding final products. Design a Booth encoder using X_i, X_{2i}, and M_i where X_i is true for $\pm Y$, X_{2i} is true for $\pm 2Y$ and M_i is true for negative partial products. (15)

6. The figure below shows the self-bypass paths for six separate ALUs of a microprocessor. The path for one of the ALUs begins at registers containing the inputs to an adder, as shown in the Fig. for Ques. 6. The adder must compute the sum. A result multiplexer chooses between this sum, the output of the logic unit, and the output of the shifter. Then a series of bypass multiplexers selects the inputs to the ALU for the next cycle. The early bypass multiplexer chooses among results of ALUs from previous cycles and is not on the critical path. The 8:1 middle bypass multiplexer chooses a result from any of the six ALUs, the early bypass mux, or the register file. The 4:1 late bypass multiplexer chooses a result from either of two results returning from the data cache (Dc1. Dc2), the middle bypass mux result (Bypass), or the immediate operand (Imm) specified by the next instruction. The late bypass mux output is driven back to the ALU to use on the next cycle. Because the six ALUs and the bypass multiplexers occupy a significant amount of area, the critical path also involves 2 mm wires from the result mux to middle bypass mux and from the middle bypass mux back to the late bypass mux. The propagation delays and contamination delays of the path are given in Table for Ques. 6.

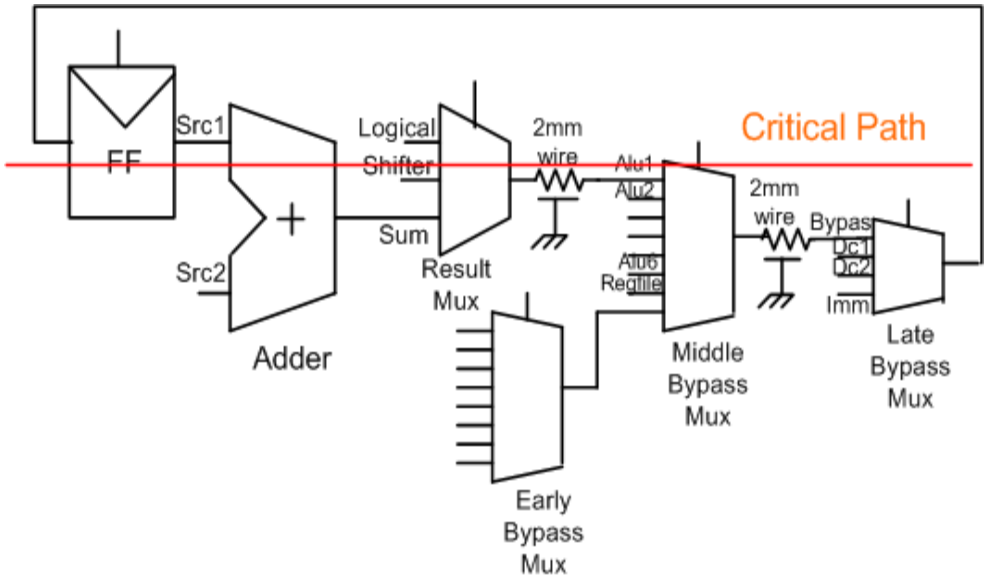

Fig. for Ques. 6

Table for Ques. 6

Element	Propagation delay	Contamination delay
Adder	450 ps	100 ps
Result Mux	50 ps	35 ps
Early Bypass Mux	110 ps	95 ps
Middle Bypass Mux	80 ps	55 ps
Late By pass Mux	70 ps	45 ps
2mm wire	100 ps	65 ps

(A) (i) Define setup time and hold time of flip-flops and propagation delay and contamination delay of logic circuits. (6)

(ii) Suppose the registers are built from flip-flops with a setup time of 62 ps, hold time of –10 ps, propagation delay of 90 ps, and contamination delay of 75 ps. Calculate the minimum cycle time Tc at which the ALU self-bypass path will operate correctly. (6)

(B)(i) If the earliest input to the Late bypass multiplexer is the imm value coming from another flip-flop, will this path experience any hold time failure? (6)

(ii) If the ALU self-bypass path uses pulsed latches in place of flip-flops, will it have any hold time problems? How can the hold time problem, if it exists, be eliminated? The pulsed latch has a pulse width of 150 ps, a setup time of 40 ps, a hold time of 5 ps, a clock to Q propagation delay of 82 ps and a clock to Q contamination delay of 52 ps, and a D-to-Q propagation delay of 92 ps. (12)

7 (a) A NAND based decoder circuit is used as row decoder of a 4K memory block. Calculate number of transistors required if CMOS circuit is used with (i) no pre-decoding and (ii) 2-bit pre-decoding. (15)

(b) Draw the transistor level circuit diagram of a 4x4 bit NOR ROM which stores the following data: (15)

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

First Column

8 (a) Consider the circuit in Fig. for Ques. 8. Determine the activity factors at each node in the circuit (node n_1, n_2 and y) assuming the input probabilities $P_A = P_B = P_C = P_D = 0.5$. Also calculate the dynamic power dissipation of each gate G1, G2 and G3. Given, output capacitance at node n1 and n2 is 10 fF each and 15 fF at node y. Given : power Supply V_{DD}= 5V, the operating frequency f = 10 MHz. (20)

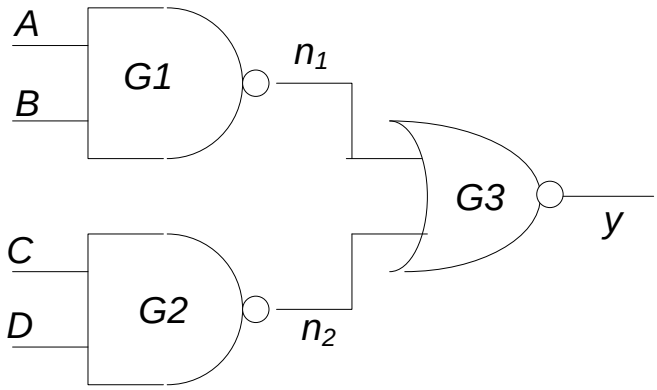

Fig. for Ques. 8

(b) Suppose that you are asked by your manager to reduce the power dissipation of the circuit shown in Fig. for Ques. 8 as much as you can. Describe what possible steps you can take to reduce the power dissipation. Assume that the process has thin oxide and thick oxide transistors and each of these transistors has two different types of V_t (high-V_t and low-V_t). (10)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

Sub: **EEE 459** (Optoelectronics)

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 4 page(s) in this question paper.

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. Draw and discuss photoluminescence spectra and absorption coefficient near and above the fundamental absorption edge for $GaAs_{1-x}P_x$ semiconductor. Draw schematic E-k diagram and estimate band gap of the semiconductor. Comment on the layer grown on GaAs substrate and compare with the layer grown on GaP substrate in terms of optical application. (30)

   Given: **x= 0.2+ Last 3 digits of your Student ID No.× 10^{-3}**

2. Design a tandem three-junction solar cell using ternary and quaternary semiconductors. Name the semiconductors used and mention their band gaps. Justify to your selection of semiconductors in terms of absorption properties and lattice matching in different layers. (30)

   Estimate efficiency of the proposed tandem solar cell mentioning various loss factors.

3. (a) Design a Laser Diode to operate at **X** nm. (20)
   Name the materials used and make justification regarding the materials chosen at different layers.

   Discuss the merits and demerits of the designed LD.

   Given:

   X =500 + 2Y nm

   (Y= Last 3 digits of your Student ID No.).

(b) Consider a Fabry-Perot laser diode operating at **W** nm. The threshold current is 6 mA. At I = 25 mA, the output optical power is 6 mW and the voltage across the diode is 1.2 V. Calculate (10)

(i) external quantum efficiency (QE),

(ii) power conversion efficiency, and

(iii) slope efficiency of the diode.

What is the forward diode current that gives an output optical power of 3 mW?

W= 400 + 5Y nm

(**Y= Last 3 digits of your Student ID No**.).

4 (a) Design a lithium niobate ($LiNbO_3$) Pockels cell phase modulator, that will operate at a free-space wavelength of **1.1+X** μm and will provide a phase shift $\Delta\Phi$ of π (half wavelength) between the two field components propagating through the crystal for an applied voltage of 12 V? (20)

Given:

At λ = **1.1+X** μm, $LiNbO_3$ has $n_o \approx 2.21$, $r_{22} \approx 5 \times 10^{-12}$ m V^{-1}.

X= Last 2 digits of your Student ID No.× 10^{-2}

(b) Consider a ZnTe crystal which rotates the optical field of the 633 nm polarized laser beam from a He-Ne laser. Calculate the necessary magnetic field for a rotation of **Y**° over a crystal length 20 mm. (10)

Given:

Y= 2+Last 2 digits of your Student ID No.× 10^{-2}

ZnTe have Verdet constant of about 188 rad T^{-1} m^{-1}, for light having wavelength 633 nm.

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) How the drawbacks of homojunction LED are overcome in double-heretostructure LED? What should be the optical properties of typical materials used in confining layers of surface emitting LEDs? Discuss the function of these confining layers. (12)

(b) The ternary alloy $In_{1-x}Ga_xAs_yP_{1-y}$ grown on an InP crystal substrate is a suitable semiconductor material for infrared wavelength LED. The device requires that the InGaAsP layer is lattice matched to InP crystal substate to avoid crystal defects in the InGaAsP layer. This in turn requires that $y \approx 2.2x$. The bandgap Eg for this ternary alloy in eV at 298 K is given by the empirical relationship, (18)

$$Eg \approx 1.35 - 0.72y + 0.12y^2; \ 0 \leq x \leq 0.47$$

(i) Calculate the compositions of InGaAsP ternary alloy for peak emission at a wavelength of 1.55 μm.

(ii) For 1.55 μm peak wavelength, what is the wavelength difference between the half intensity points in the output spectrum? Assume that the spread in the photon energies $\Delta(hv) \approx 3k_BT$ between the half intensity points.

6. (a) Explain how recombination center is produced by nitrogen incorporation in $GaAs_{1-x}P_x$. Discuss the effect of nitrogen incorporation in $GaAs_{1-x}P_x$ LED in terms of emission wavelength and quantum efficiency. (14)

(b) Calculate (i) radiative recombination efficiency, (ii) external quantum efficiency, and (iii) extraction efficiency for a GaAs n^+-p junction 867 nm infrared LED. Consider, the active region i.e., p-side of the junction have doping concentration of 5×10^{16} cm^{-3} and the nonradiative lifetime is about 50 ns. When 1.2 V voltage was applied across the LED, a forward current was measured to be 30 mA, and the emitted optical power was found to be 6 mW. Assume, $B_r = 7 \times 10^{-10}$ cm^2s^{-1} for GaAs. (16)

7. (a) Suggest a structure with necessary schematics for overcoming the total internal reflection problem in the LEDs. Among the homojunction, heterojunction and quantum well LEDs, which one is expected to have the narrowest emission linewidth? (15)

(b) If semiconductor slab of length *l*, width *w*, and depth *d* shown in Fig for Q. 7(b) acts as a photoconductive detector, mention the factors on which the photocurrent and photoconductive gain of this detector depend? Which factor limits the speed of response of the detector? (15)

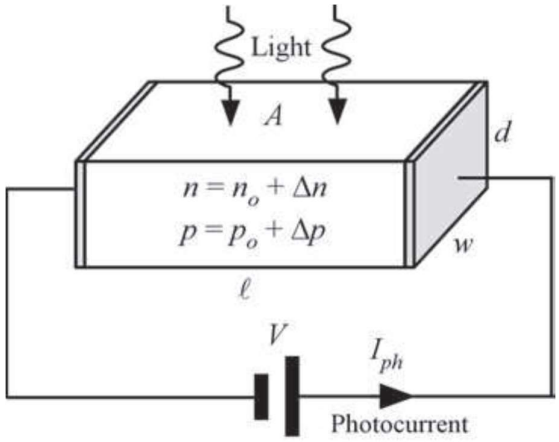

Fig for Q. 7(b)

8. (a) With necessary schematics and band diagrams briefly discuss the operational principle of a Schottky junction photodiode. Schottky junction photodiodes are better suited for detecting short-wavelength light than *pn* and *pin* photodiodes – justify the statement. Why Schottky junction photodiodes can be significantly faster than *pn* and *pin* photodiodes? (15)

(b) A Ge APD has a quantum efficiency of 50% at 1.55 μm in the absence of multiplication. It is biased to operate with a multiplication of 20. (i) Calculate the photocurrent if the incident optical power is 50 nW. (ii) What is the responsivity when the multiplication is 20? (15)

L-4/T-2/EEE **Date: 23/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2019-20

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

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 3 page(s) in this question paper.

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) What is collisional broadening of electronic states? Comment on relative collisional broadening of electronic states in one-, two-, and three-dimensional materials. (12)

   (b) Derive the electron transmission coefficient in a resonant tunneling diode. How will the transmission coefficient be affected if an electric field is applied across the resonant tunneling diode? (18)

2. (a) How the perturbation changes the Hamiltonian for an electronic state due to the interaction with photons? How is it different from that when the interaction happens due to phonons? (12)

   (b) An electron is in the second state of a GaAs quantum well of width 15 nm, which can be treated as an infinitely deep one-dimensional system. Suddenly the middle 5 nm becomes 100 meV deeper. Use the golden rule to derive an expression for the rate at which the electron scatters into the first, third and fourth states, and evaluate the rate for the lowest allowed transition. (18)

3. (a) Discuss the dependence of phonon scattering rate with temperature. Comment on the comparison between interband transitions due to phonons vs. intersubband transitions due to phonons. (12)

   (b) Calculate the transmission and reflection flux coefficient for an electron of energy E, moving from left to right, impinging normal to the plane of a semiconductor heterojunction potential barrier of energy V_0, where the effective electron mass on the left-hand side is m_1 and the effective electron mass on the right-hand side is m_2. (18)

If the potential barrier energy is V_0 = 1.5 eV and the ratio of effective electron mass on either side of the heterointerface is $m_1/m_2 = 3$, at what particle energy is the transmission flux coefficient unity?

4 (a) What determines the selection rules for optical transitions at frequency ω between states i and j? (10)

(b) An electron is initially in the ground state of a one-dimensional rectangular potential well for which $V(x) = 0$ in the range $0 < x < L$ and $V(x) = \infty$ elsewhere. The ground state energy is E_1 and the first excited state energy is E_2. At time $t = 0$, the system is subject to a perturbation $V_0 x^2 e^{-t/\tau}$. Calculate and plot the probability of finding the particle in the first excited state as a function of time for $t \geq 0$. In your plot, normalize time to units of τ. (20)

SECTION – B

There are FOUR questions in this section. Answer any THREE

All the symbols have their usual meanings

5. (a) The dispersion relation of a linear diatomic lattice is given by the following equation where different symbols have their usual meanings. (18)

$$\omega^2 = \frac{C(m+M)}{mM}\left[1 \pm \sqrt{1 - \frac{4mM\sin^2 ka}{(m+M)^2}}\right]$$

Considering $M > m$, derive the dispersion relation for the acoustic branch.

(b) According to Kronig-Penny model, do you expect the energy gap to increase or decrease as electron energy increases? Why? Draw the reduced zone representation of the E-k diagram in accordance with your answer. (12)

6. (a) Consider the following expression of internal energy where different symbols have their usual meanings. (18)

$$U = 3N\langle\varepsilon\rangle = \frac{3N\hbar\omega}{2} + \frac{3N\hbar\omega}{e^{\hbar\omega/k_bT} - 1}$$

Based on this relation, derive the expression of specific heat and discuss how your derivation deviates from experimental observation.

(b) 'Thermal blurring of electron distribution is more significant in the degenerate limit'- do you agree with this statement? Justify your answer with necessary equations and diagram. (12)

7. (a) Consider a finite potential well which has a single energy state E_1 and corresponding wavefunction Ψ_1 under equilibrium. Suppose a small external DC voltage V_o is applied to it. Based on perturbation theory, derive the expression of second-order corrected energy state and first order corrected wavefunction. (20)

(b) Define Reststrahlen peak. Between NaCl and GaAs, in which material do you expect Reststrahlen effect to be stronger and why? (10)

8. (a) Based on tight-binding model, show with necessary equations how bringing a pair of wells of identical atoms causes the energy level to split into two levels. (20)

(b) For a 1-D monoatomic lattice, draw the dispersion relation where the two transverse modes correspond to two different phase velocities. For what kind of crystals phase velocities of the two transverse modes will be identical? (10)

L-4/T-2/EEE **Date: 16/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

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

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 2 page(s) in this question paper.

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) In high voltage (HV) AC generation the deviation of HV from sinusoid of fundamental frequency should be limited to 5% of peak value. What problem will a higher deviation cause and how? (7)

   (b) In what type of high voltage testing would you consider using a resonance transformer? In such tests the test object is considered pure capacitive. What is the basis of such consideration? What effect does this capacitance have on the test? (8)

   (c) Briefly present the operating characteristics of the resonant transformer circuit with variable test frequency. (15)

2. (a) In electrical breakdown of gases, it is noted that the effectiveness of ionization by electron impact depends upon energy that an electron can gain along mean free path in the direction of field. (15)

   (i) Explain "mean free path." What effect does temperature and pressure have on it? Comment on the mean free path of an atom in its own gas and that of an electron in a gas.

   (ii) What is collision cross-section? What is its relation with mean free path? What factors may affect collision cross-section?

   (b) Townsend introduced two ionization coefficients to explain electrical (15)

breakdown of gases. Discuss the physical phenomena these coefficients signify.

3. Explain the 'Kanal' mechanism of spark. (30)

4. (a) Present a qualitative comparison of the characteristics of anode corona and cathode corona in atmospheric air. (20)

(b) For purpose of coordinating electrical stresses with electrical strengths two characteristics are important, overvoltage distribution and insulation breakdown probability. How are these used to assess insulation failure risk? (10)

SECTION – B

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

5. (a) With neat diagrams, describe the operating principle of three different voltage doubler circuits. For each circuit, mention when the diodes conduct and explain how voltage is doubled at the output terminal. (20)

(b) Derive the expression of Ripple Factor for Cockcroft–Walton type voltage doubler circuit. (10)

6. (a) With necessary diagrams explain how peak value of ac voltage and impulse voltage can be measured. (20)

(b) Mention the principal sources of error in Chubb–Fortescue method. (10)

7. (a) Explain how breakdown occurs in solid dielectrics due to edge effect, treeing and tracking. How can these be prevented? (25)

(b) Discuss the effect of the frequency of the applied voltage on thermal breakdown strength of a solid dielectric. (05)

8 "Presence of solid and gaseous impurities in liquid insulation has a profound effect on breakdown strength of liquids"- Briefly explain the mechanism of liquid breakdown in presence of such impurities. (30)

L-4/T-II/EEE **Date: 12/1/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

Sub: **EEE 487**(Nuclear Power Engineering)

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 3 page(s) in this question paper.

SECTION – A

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

All the symbols and abbreviations have their usual meanings.

Assume reasonable values for missing data (if any).

1. (a) What do you mean by enrichment? What are the methods for enrichment based on atomic mass number of isotopes? (12)

   (b) Derive a simple formula relating feed, product and waste (tail) per day in a uranium enrichment plant. (10)

   (c) How many kg of natural U-238 is required in an enrichment process to obtain 1 kg product with 5% U-235? Given that the abundance of U-235 in natural uranium is 0.7% and U-235 must not be more than 0.3% in the waste. (8)

2. (a) What is meant by off-site and on-site power systems in relation to a nuclear power plant? What are their functions? (12)

   (b) What is Class 1E subsystem? What are the main functions of the I&C system in a nuclear power plant? (12)

   (c) Explain the terms LOOP, SBO and LOCA. (6)

3. (a) Explain the impacts of grid frequency and voltage on a nuclear power plant operation. (15)

   (b) Explain the impacts of the size of a nuclear power plant unit on the grid operation. (15)

4 (a) What are the situations in which a nuclear power plant has to "Scram"? (5)

(b) Explain the root causes of Three Mile Island, Chernobyl and Fukushima Daiichi nuclear power plant accidents. (15)

(c) Explain nuclear fuel cycle, front end, back end, open cycle and closed cycle. (10)

SECTION – B

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

All the symbols and abbreviations have their usual meanings.

Assume reasonable values for missing data (if any).

5. (a) What is nuclear fission and fusion? With necessary equations and diagrams, explain the fission process in U-235 nuclei. (15)

(b) Assume 80% of neutrons are absorbed by U-235 cause fission and rest being absorbed by the non-fission capture to produce an isotope U-236. Each fission of U-235 yields 190 MeV of useful energy. Estimate the fuel consumption of U-235 per hour to produce 100 MW of thermal power. (15)

6. (a) With necessary diagrams, explain the steam generation and electrical power production in a nuclear power plant. (15)

(b) (i) What is waste heat rejection in a nuclear power plant? (15)

(ii) A nuclear reactor produces 3000 MW of thermal power. The water enters at 300 ^{o}C and leaves at 325 ^{o}C. Assuming the water is at 2000 psi and 600^{o}F (PWR conditions), find the amount of circulating water in litres/minute to cool the reactor. Given that the specific heat is 6.06 x 10^3 J/(kg. ^{o}C) and the density is 687 kg/m^3.

7. (a) Write down the attributes of Generation III, Generation III+ and Generation IV nuclear reactors. (15)

(b) With necessary illustrations, briefly explain the construction and operation of a Pressurized Water Reactor (PWR). (15)

8. (a) A 1000 MWe nuclear unit built for $2 billion achieves a capacity factor of 90% with a burn-up of 30,000 MWD/MTU. Fuel costs are $1025/kg and O&M expenses are $60 million/year. Find the electricity generation cost of this plant by considering a levelized fixed charge rate of 17%/year. (10)

(b) Write down the key characteristics of six next generation nuclear reactors. Explain the role of next generation reactors in hydrogen economy. (20)

L-4/T-II/EEE **Date: 23/1/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

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

Full Marks: 180 Time 2 Hours

The Figures in the margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 3 page(s) in this question paper.

SECTION – A

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

All the symbols and abbreviations have their usual meanings

1. (a) Define the grid reliability indices: SAIFI, SAIDI and ASAI. What are the IEEE standard limits for SAIFI and SAIDI? How can smart grid help avoid exceeding these limits? (18)

   (b) Explain transactive energy (TE). What are the differences between TE and DR (demand response)? (12)

2. (a) Define grid resiliency and grid hardening. How can smart grid help achieve these? (14)

   (b) What is the difference between "consumer" and "prosumer"? Explain how a photovoltaic (PV) plant can be controlled to reduce the output at a given irradiance, in response to a command from the load dispatch centre ? (16)

3. (a) What are the bay controllers in a substation? Using diagrams show two types of communication between bay controllers and the substation computer or RTU. (14)

   (b) Using a diagram show a typical architecture for communication between a smart meter and the utility server. (10)

   (c) What type of communication technology is employed between a DCU and a smart meter and between a DCU and the gateway? (6)

4 (a) There are 250,000 smart meters in a power distribution system and there are 1000 concentrators. The data network is designed such that if one link from a concentrator fails, another link will transmit the data. Each smart meter sends 3 bytes of data every second. Then what should be the average data rate through a data link between the concentrator and the server? (10)

(b) Write down the application areas of following communication technologies in smart grid. (10)
Bluetooth, ZigBee, 6LoWPAN, WiMax, FOC.

(c) What is protocol? Mention the names of widely used protocols along with their applications in power system or smart grid communication. (10)

SECTION – B

There are **FOUR** questions in this section. Answer any **THREE**
All the symbols and abbreviations have their usual meanings

5. (a) What is a smart grid? What are the motives behind implementing a smart grid? Compare a traditional grid with a smart grid in terms of power generation, transmission, distribution and control. (15)
(b) Provide an overview of the following technological requirements for a smart grid. (15)
(i) Information and communication technologies, (ii) Sensing, measurement, control and automation technologies and (iii) Power electronics and energy storage systems.

6. (a) Present a list of electrical and non-electrical energy storage systems. Describe the possible solutions to uncertainties of power output from variable renewable energy sources in a power system. (15)
(b) What are the differences between Home-Area Network (HAN) and Internet of Things (IoT)? Provide a brief description of a HAN. (15)

7. (a) With necessary diagrams, explain the following services provided by Demand-Side Integration (DSI). (15)

(i) Load shifting, (ii) Valley filling, (iii) Peak clipping and (iv) Energy efficiency improvement.

(b) Define price elasticity of demand and elasticity of substitution. How can DSI enable frequency control support in a smart grid? (15)

8. (a) What is a microgrid? Define self-healing and restoration process. (10)

(b) Explain (i) the hierarchical control and (ii) islanded mode operation of any typical microgrid. (20)

L-4/T-2/EEE **Date: 16/01/2021**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-II B.Sc. Engineering Examination 2018-19

Sub: **EEE** 497 (Telecommunication Networks)

Full Marks: 180 Time 2 Hours

The Figures in the right margin indicate full marks

USE SEPARATE SCRIPTS FOR EACH SECTION

There are 4 page(s) in this question paper.

SECTION – A

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

All the symbols have their usual meanings

1. (a) Apply the Dijkstra algorithm and determine the shortest paths from the source node A to the destination nodes E and G for the network shown in Fig. 1(a). (15)

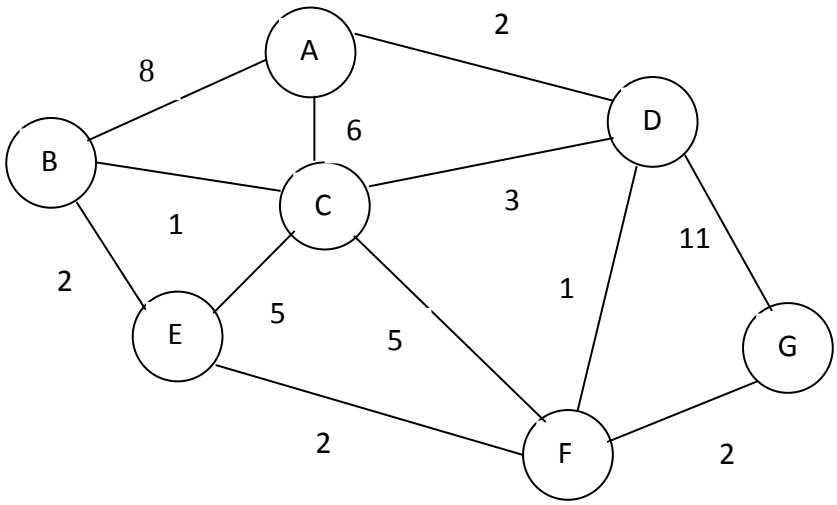

Fig. 1(a)

(b) Suppose, BUET is granted a block of IP addresses with the beginning address 172.196.120.0/22. The number of hosts in some of departments of BUET is given in Table 1. Design the sub-networks for the mentioned departments of BUET providing sub-network address, sub-net mask and sub-network host addresses. (15)

Table 1: No. of hosts for each Department

Dept. Name	No. of Hosts
ME	30
CE	56
CSE	130
EEE	100
BME	12

.

2. (a) In a TCP operation, the initial values of smoothed round-trip time and round trip time variation are 100 ms and 10 ms, respectively. The acknowledgement times of a sequence of frames are 100 ms, 90 ms, 80 ms, 100 ms, 70 ms, 90 ms, 80 ms, 60 ms and 90 ms. Calculate the retransmission time out (RTO) at the end of all the sequence. Assume, $\alpha=7/8$ and $\beta=3/4$. (15)

(b) In a TCP Tahoe operation, the initial value of slow start threshold is 64 kB and the length of each frame is 2 kB. The buffer size is assumed to be 80 kB where the frame loss starts. Draw the congestion window versus transmissions rounds (RTTs) showing slow start, additive increase and multiplicative decrease phases. (15)

3. (a) How do the RTP and RTCP work in VoIP application along with UDP? Explain, why TCP does not perform well for VoIP. (15)

(b) Consider an H.323 client X wants to perform VoIP communication with an H.323 client Y. Explain, the operation of connection set up, communication and connection release between the VoIP clients. (15)

4 (a) Consider the two ISDN Layer-3 entities A and B. Describe how the association is completed by the two entities. (15)

(b) Explain the meaning of the following 5 byte ATM header. (15)

1010 1001

1001 0101

1010 1010

1101 0110

1010 0101

SECTION – B

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

All the symbols have their usual meanings

5. (a) What could be the possible problems if packet switching is used for voice application and circuit switching is used for data application? Explain with justification. (10)

(b) Networks can be classified as access networks and backbone networks. With justifications and mentioning the advantages and disadvantages, explain which topologies should be used and should not be used for access networks and backbone networks. (20)

6. (a) The multistage switching system shown in **Fig. for Q. No. 6(a)** has 12 inlets. Determine - (20)

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

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

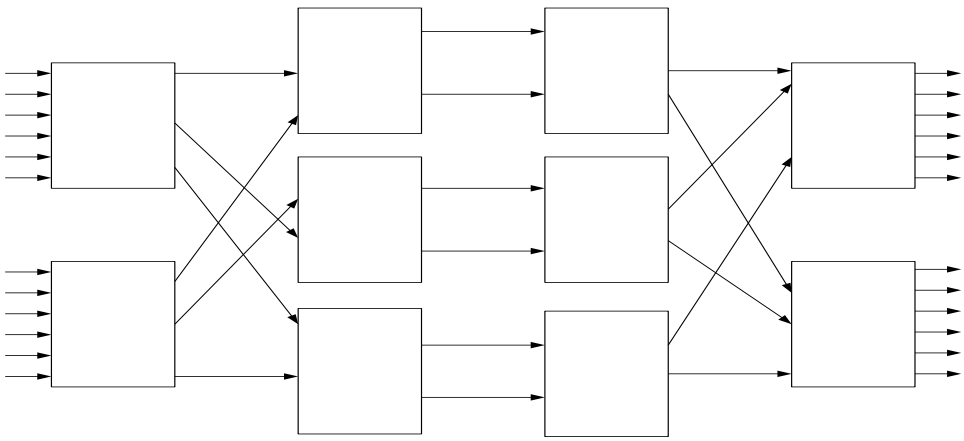

Fig. for Q. No. 6(a)

(b) Explain how the time switching is operated in digital TDS. (10)

7. (a) In a slotted ALOHA system, the packet arrival rate is λ packets/sec. The length of each packet is 1000 byte and the data transmission rate is 2 Mbps when a packet is transmitted. Determine the value of λ for achieving the maximum throughput. Also, determine the maximum throughput in packets/sec and Mbps. (10)

(b) Explain how the CSMA/CA MAC protocol manages the effect of increasing and decreasing the numbers of users in a WLAN. Also explain the trade-off between the hidden terminal problem and exposed terminal problem in a CSMA system with carrier sensing range. (20)

8. (a) Distinguish among SDH, WDM and OTN in terms of operating principle, data rate and applications. (15)

(b) Explain how the routing and forwarding of MPLS technology are different from the routing and forwarding of IP technologies. (15)