L-4/T-1/EEE Date: ~~28/04/2024~~ 19/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **EEE 401** (Machine Learning and Artificial Intelligence)

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. **Q. No. 1 is compulsory**.

Answer any **TWO** questions from **Q. No. 2–4**.

Symbols used have their usual meaning.

1. (a) What is the main difference between the collaborative filtering and content-based recommendation systems? Between person-1 and person-2, whom should you recommend jogging? Features for three types of physical exercises are shown in the table and parameter vectors for person-1 and person-2 are given beside. Use logistic regression. **(10)** (CO4)

Movie Types	Features				
	x_0	x_1	x_2	x_3	x_4
Mild exercise	1	0.2	0.5	0.6	0.7
Walking	1	0.7	0.6	0.6	0.4
Jogging	1	0.8	0.7	0.8	0.6

$\theta^{(1)} = [0.7, 0.6, 0.5, 0.7, 0.8]$

$\theta^{(2)} = [0.9, 0.6, 0.7, 0.8, 0.9]$

(b) Given the speed (20 km/hr), load (2 kg) and height (6 m) of a drone, find the decision whether it will fly or not using the ANN structure shown in Fig. for Q. No. 1(b) (use sigmoid activation function as indicated). **(10)** (CO6)

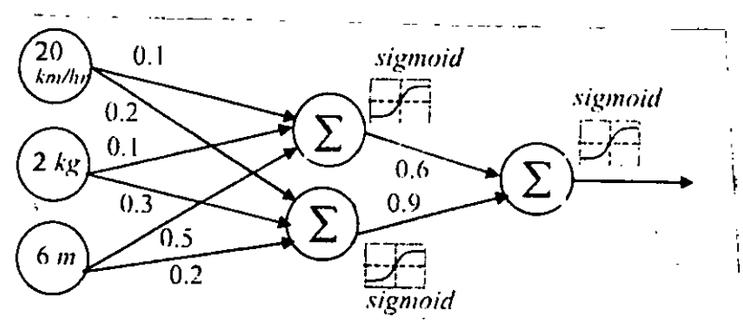

Fig. for Q. No. 1 (b)

(c) Design a CNN-based deep neural network classifier that can classify a plant leave as healthy or diseased class. Images of plant leaves (size 128×128) taken from 5

Contd P/2

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Contd... Q. No. 1(c)

different types of plants are available (both plant type and healthy/diseased markings are available). Use 2D CNN blocks where each block includes 2D CNN operation and some necessary basic operations. You only need to sketch the architecture with necessary information such as kernel size, number of filters, stride, dilation and output size. **(10)** (CO5, CO6)

(d) What is transfer learning in deep learning based techniques? **(5)** (CO5)

2. (a) What is "backpropagation" in deep neural network model? With a schematic diagram explain channel attention, spatial attention, and pixel attention mechanisms used in CNN-based deep learning network. **(8)**

(b) A convolution operation is carried out between 9×9 input and 3×3 filter shown in Fig. for Q. No. 2(b) (without any padding and considering stride = 1). Find ONLY the value of the center point of the output. If 3×3 Maxpool operation is performed on the 9×9 input with a stride 3, find the output. **(10)**

-1	1	0	0	-1	0	-1	0	0
0	-1	1	0	1	0	0	1	0
0	1	-1	1	-1	0	0	0	1
-1	0	0	0	1	0	0	-1	1
0	1	0	0	1	0	0	1	-1
0	0	1	0	-1	0	-1	0	0
-1	0	0	0	1	0	-1	1	0
1	0	0	-1	1	0	1	-1	1
1	0	0	1	-1	-1	0	0	0

0	0	0
1	0	0
0	1	0

Fig. for Q. No. 2 (b)

(c) Compare the three basic CNN architectures shown in Fig. for Q. No. 2(c). **(9)**

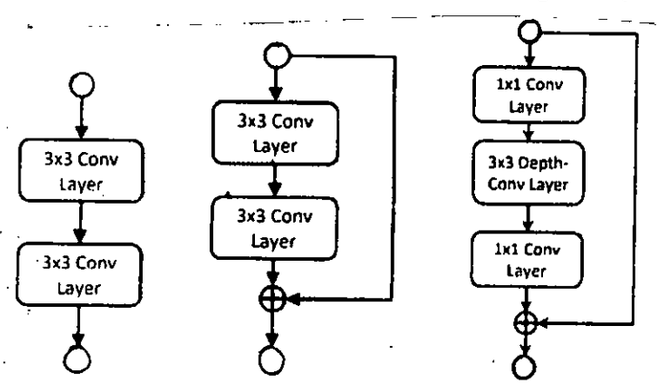

Fig. for Q. No. 2(c)

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Contd... Q. No. 1

(d) For the blank box shown in Fig. for Q. No. 2(d) find the values of kernel size (K), stride (s), number of filters (f), and basic operations as. Also, find the output size. **(8)**

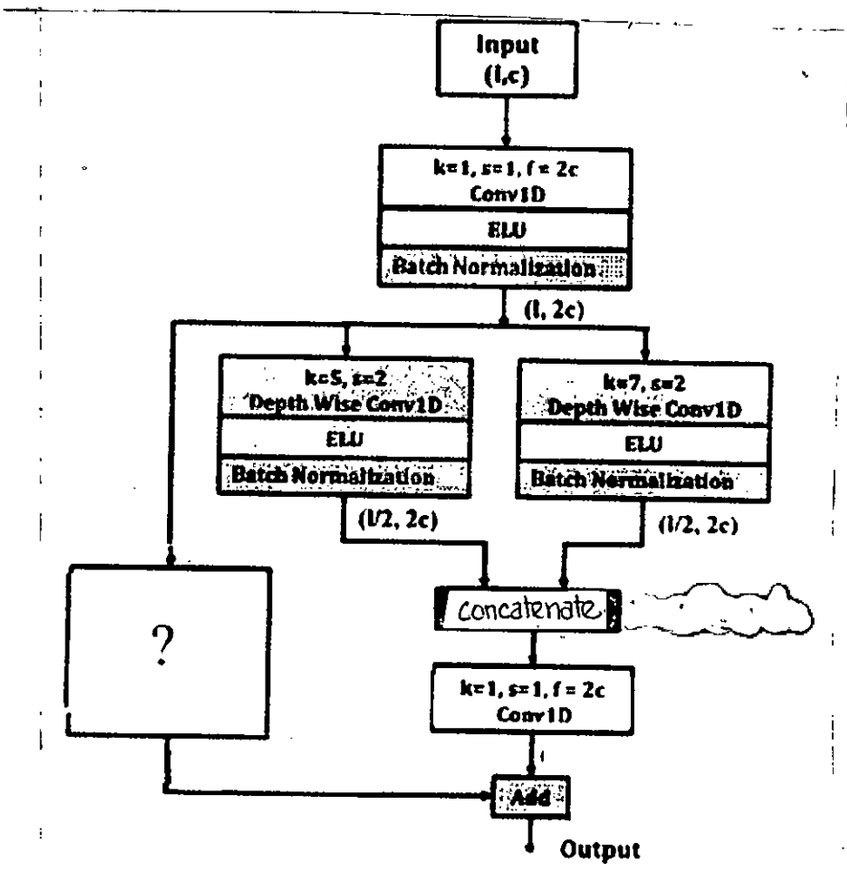

Fig. for Q. No. 2(d)

3. (a) Draw an encoder-decoder structure suitable for segmenting 128×128 input images. **(10)**

(b) What is data mining? How machine learning can be used in predictive and descriptive data mining tasks? **(7)**

(c)What are the five Steps in Problem Solving Agent? Show the basic operation of a goal-based agent with the help of an Agent-Environment schematic diagram. **(13)**

(d) What is the main advantages of using transformer network over the conventional CNN network? **(5)**

4. (a) (i) State A* Search algorithm. What is the main difference between A* Search and Uniform Cost search algorithm? (ii) From the Fig. for Q. No. 4(a) find the optimal path reach the Goal (G) from the Start point (S) by using A* search algorithm show intermediate costs during path selection). **(15)**

Contd P/4

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Contd... Q. No. 4(a)

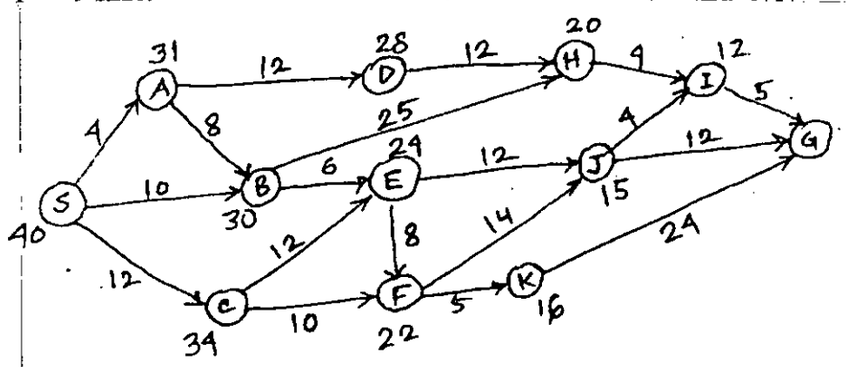

Fig. for Q. No. 4(a)

(b) A robot moves at two locations (L), checks the presence/absence of garbage (G) and collects (C) garbage if available. After moving to a location, robot waits for 20 seconds to collect the garbage and then leaves that location. Write an algorithm considering the application using Simple-Reflex-Agent method. **(8)**

(c) Consider smoke (S), heat (H) and fire (F). For the following expression, construct the truth table for all possible binary combinations. **(7)**

$$((S \wedge H) \Rightarrow F) \Leftrightarrow ((S \Rightarrow F) \vee (H \Rightarrow F))$$

(d) Briefly mention the major differences between Breadth-First Search and Depth-First Search. **(5)**

SECTION – B

There are **FOUR** questions in this section. Answer to **Question No. 5 is compulsory.**

Answer any TWO questions from Questions 6-8.

5. (a) What are the differences between supervised, unsupervised, and semi-supervised learning? What is the advantage of self-supervised learning over the supervised learning? **(10)** (CO1)

(b) What is KNN classification? Is there any training process involved in the KNN algorithm? Use KNN algorithm to declare the status of a test sample (pass or fail) with feature value score = 72 and type = 2. Justify your choice of K. Training data is given in the table below. **(15)** (CO2)

Contd P/5

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

Table for Q. 5(b)

Score	Type	Decision
75	1	Pass
86	2	Pass
68	1	Fail
88	1	Pass
55	1	Fail
63	2	Fail

(c) State the Gradient Descent update equation. What will happen if learning rate is chosen very small or very large in Gradient Descent search? (10) (CO3)

6. (a) What is support vector? Find an expression for margin of separation (M) in a support vector machine (SVM) binary classifier and comment on the performance of the classifier with respect to the expression. What are the limitations of an SVM classifier? **(20)**

(c) Consider a dataset with 4 examples and 4 features. **(15)**

X	y
[1 1 0 1]	1
[1 0 0 1]	0
[1 1 1 0]	1
[1 0 1 1]	0

We want to perform logistic regression using gradient descent optimization. Assuming initial parameter vector θ = [0, 0, 0, 0] and learning rate α = 0.8, find the new parameter vector after the first iteration. Show your calculation step by step.

7. (a) What is the main purpose of using Kernel function in supervised classification? Give examples of two commonly used kernel functions. **(11)**

(b) What is the basic difference between feature selection and feature mapping? Explain wrapper approach of feature selection. What are the advantages and disadvantages of this approach? Will you prefer sequential forward selection (SFS) or sequential backward selection (SBS) in this case? **(13)**

(c) Define classification and regression. What are the popular loss functions used in regression and classification problem? **(11)**

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8. (a) Write briefly the steps needed to reduce the feature dimension using the Principle Component Analysis (PCA). **(15)**

(b) From the feature map shown in Fig. for Q 8(b), two clusters need to be obtained. **(20)**

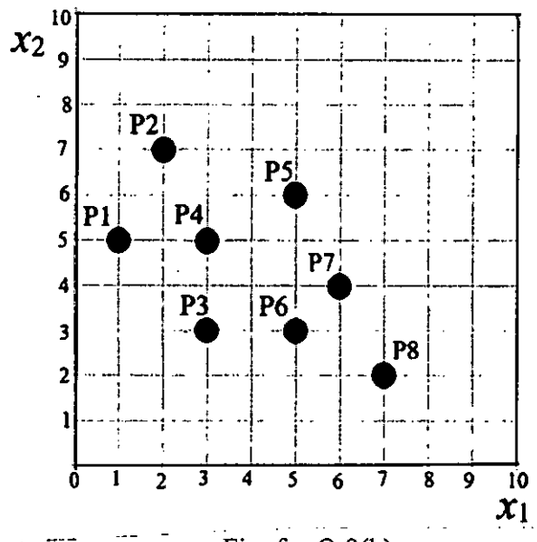

Fig. for Q 8(b)

(i) Use K-means clustering with initial cluster centroids P4 and P6. After one iteration, find the two new cluster centroids and respective class members.

(ii) Find two clusters using hierarchical clustering.

(iii) In the same feature space, if a new feature is found located at (20, 10), how that will affect the clustering performance? What is your recommendation in this case?

Course Outcomes of EEE 401

CO No.	CO Statement
CO1	understand the fundamentals of AI and machine learning algorithms with real life applications
CO2	solve real-life problems by designing suitable AI based algorithm
CO3	analyze real life challenges in implementing supervised and unsupervised learning algorithms
CO4	apply knowledge of regression analysis for effective recommendation
CO5	design deep learning models suitable for performing classification task
CO6	experience real life applications of ML and DL techniques

L-4/T-1/EEE Date: ~~28/04/2024~~ 19/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2022-2023

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

The corresponding Course Outcomes (COs) of each part of Question 1 and 5 are mentioned on the right most column. The COs of the Course are mentioned at the end of the question paper.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer to **Question No. 1 is compulsory.**

Answer any TWO questions from Questions 2-4.

1. (a) Derive the condition for economic distribution of load between two units within a power plant. Then analyse the classical economic dispatch process of thermal power plants incorporating transmission line losses. **(5+15)** (CO2)

(b) 500MW wind farm is connected to two transmission regions as shown in Fig. Q1(b). At a given instant the wind farm supplies 200 MW to each region. When the power output from wind farm increases to 450 MW, it is necessary to send 250 MW to area 1 and 200 MW to area 2. Given that the voltage magnitude and angle of the busbar of region 1 and region 2 to which tie line is connected do not change, how will you achieve this condition using FACTS device? Which FACTS device will you use? **(15)** (CO4)

Draw the connection diagram and discus show to achieve increased power transfer to area 1.

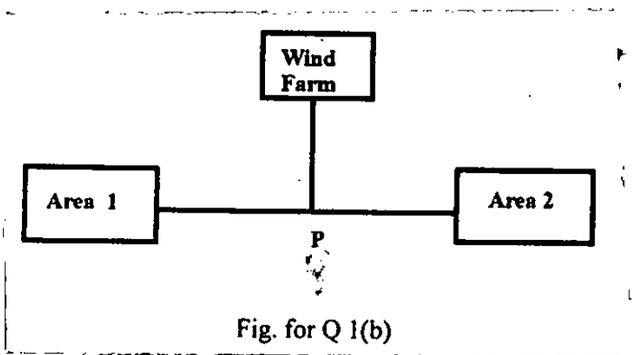

Fig. for Q 1(b)

2. (a) Why FACTS are used in the transmission system? Name five thyristor-based FACTS. **(10)**

(b) Briefly describe the operation of STATCOM, TCBR and UPFC **(15)**

(c) What are the differences between STATCOM and SVC **(10)**

Contd P/2

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3. The generating units at two different power plants have incremental fuel costs in dollars per megawatt hour given by **(35)**

$$\frac{df_1}{dP_{g1}} = 0.0080P_{g1} + 8.0$$

$$\frac{df_2}{dP_{g2}} = 0.0096P_{g2} + 6.4$$

Where P_{g1} and P_{g2} are expressed in megawatts. At the specified load level of 500 MW the loss coefficient in per unit on a 100 MVA base are given by

$$\left[\begin{array}{cc|c} B_{11} & B_{12} & B_{10}/2 \\ B_{21} & B_{22} & B_{20}/2 \\ \hline B_{10}/2 & B_{20}/2 & B_{00} \end{array}\right] = \left[\begin{array}{cc|c} 8.383183 & -0.049448 & 0.375082 \\ -0.049448 & 5.963568 & 0.194971 \\ \hline 0.375082 & 0.194971 & 0.090121 \end{array}\right] \times 10^{-3}$$

(i) Find the initial estimate of incremental fuel cost (λ) of the plant assuming the initial load level is 500 MW.

(ii) Calculate transmission line loss from the given B coefficients.

(iii) What is the system λ after first iteration?

(iv) Find the penalty factors of two power plants.

(v) Calculate the incremental fuel costs in $/MWh.

4. (a) What are inter harmonics? Briefly discuss the sources of harmonics. **(10)**

(b) What is flicker? What are remedies of flicker? **(10)**

(c) Define the following: transients, voltage swell, undervoltage, voltage sag. Suggest two device names that would solve any two of the power quality problems stated above and describe the operating principle of the devices. **(15)**

SECTION – B

There are **FOUR** questions in this section. Answer to **Question No. 5 is compulsory.**

Answer any TWO questions from Questions 6-8.

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

5. (a) Suppose, there are two isolated power systems each looks like the SMIB system shown in the Fig. for Q. 5(a) Specifications of different components in the two systems are described in Table 5(a). **(8+7)** **(CO3)**

(i) Which system you think is more stable than the other one in terms of transient stability? Explain your answer with proper reasoning.

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

(ii) Suggest some design and operational strategies to improve transient stability of the less stable system.

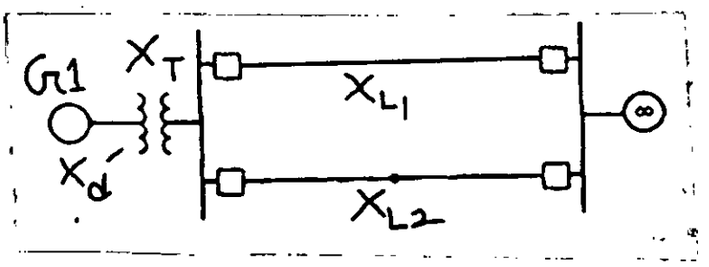

Fig. for Q. 5(a).

Table for Q.5(a)

Description	System-01	System-02
Inertia constant H of G_1	5 MJ/MVA	7 MJ/MVA
Sub-transient reactance X_d' of G_1(pu)	0.2	0.1
Leakage reactance of T_1(pu)	0.1	0.1
Line reactance of L_1(pu)	0.4	0.3
Line reactance of L_2(pu)	0.4	0.3
Internal voltage magnitude E_1' of G_1(pu)	1.05	1.10
Activation time of relay	20 cycles	10 cycles
100% valve opening/closing time of	10 seconds	5 seconds

(b) Present a systematic approach to access the frequency response of a system by estimating frequency sensitivity index. **(20)** (CO1)

6. (a) Discuss the assumptions considered for multimachine transient stability analysis to reduce the computational burden. **(10)**

(b) Briefly explain how the steady state voltage stability analysis might be carried out using P-V curve method. **(10)**

(c) Derive the expression of Fast Voltage Sensitivity Index (FVSI) and explain how this index can be used to assess voltage stability of a bus. **(15)**

7. (a) The rectangle shown in the Fig. for Q. 7(a) represents the transmission system of linear passive components, such as transformers, transmission lines, and capacitors, and includes the transient reactance of the generator. The voltage E_1' represents the transient internal voltage of the generator at bus-1 which has a mechanical input power P_m and the voltage E_2' at the receiving end is regarded here as the voltage of an infinite bus.

Contd P/4

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

(i) Prove that the power angle equation of the generator can be written as $P_e = P_{max} \sin\delta$. Do necessary assumptions. **(10)**

(ii) Let there be a sudden three-phase fault somewhere in the transmission network of Fig. for Q. 7(a). After some time, the fault is cleared by tripping circuit breakers. If the power angle equations during and after fault are **(11)**

$$P_{e,df} = P_{max1} \sin\delta \text{ and } P_{e,af} = P_{max2} \sin\delta$$

respectively, then using equal area criterion, derive the critical clearing angle, δ_{cr} in terms P_m, P_{max}, P_{max1} and P_{max2}.

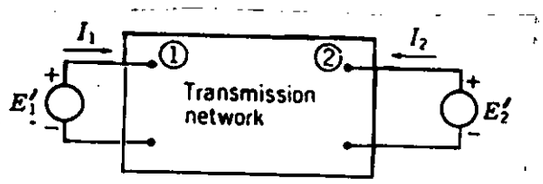

Fig.for Q. 7(a)

(b) Derive the expression the Synchronizing Power Coefficient and explain its significance in rotor angle stability. **(10+4)**

8. A 60-Hz 230 kV transmission system shown in the Fig. for Q. 8 has two generators of finite inertia and an infinite bus. A three-phase fault occurred at line 4-5 near bus 4, which was cleared after 0.25 seconds by simultaneously opening the circuit breakers at the two ends of the faulty line. The generator data, prefault power flow solutions, Bus Admittance Matrix (reduced to machine nodes) during and after fault condition are given in Table 8(i), 8(ii), 8(iii). Answer the following-

(a) Determine the swing equations of the generators during and after fault period. **(15)**

(b) Taking time interval, $\Delta t = 0.10$ seconds, calculate the rotor angle of Generator2 (δ_2) in each step up to $t = 0.40$ seconds. (Use the step-by-step solution technique) **(20)**

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contd..... P/5

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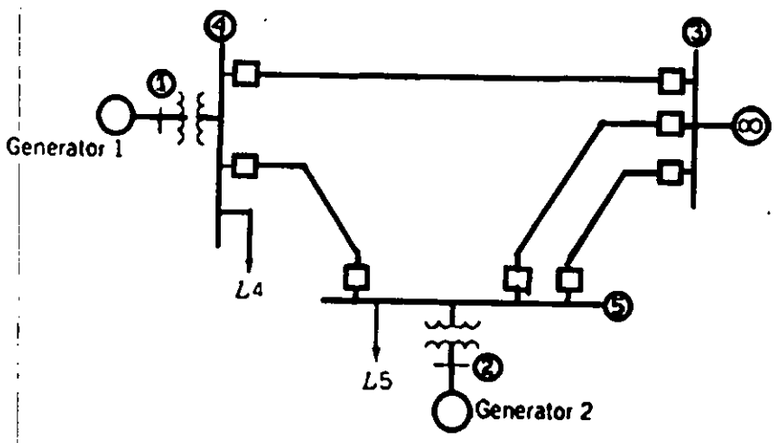

Fig for Q. 8

Table 8(i): **Generator data (Estimated on a common base)**

Generator 1	$X'_d = 0.067$ per unit	$H = 11.2\ MJ/MVA$
Generator 2	$X'_d = 0.10$ per unit	$H = 8.0\ MJ/MVA$

Table 8(ii):

Bus data and prefault load flow values (in per unit, estimated on a common base):

Bus	Voltage	Generation		Load	
		P	Q	P	Q
1	$1.030\ \angle 8.88^0$	3.500	0.712	–	–
2	$1.020\ \angle 6.38^0$	1.850	0.298	–	–
3	$1.000\ \angle 0.00^0$				
4	$1.018\ \angle 4.68^0$	–	–	1.00	0.44
5	$1.011\ \angle 2.27^0$	–	–	0.50	0.16

Table 8(iii):

Bus Admittance Matrix (in per unit, estimated on a common base):

Faulted network			
Bus	1	2	3
1	$0.0000 - j11.2360$ $(11.2360\ \angle -90^0)$	$0.0 + j0.0$	$0.0 + j0.0$
2	$0.0 + j0.0$	$0.1362 - j6.2737$ $(6.2752\ \angle -88.7563^0)$	$-0.0681 + j5.1661$ $(5.1665\ \angle 90.7552^0)$
3	$0.0 + j0.0$	$-0.0681 + j5.1661$ $(5.1665\ \angle 90.7552^0)$	$5.7986 - j35.6299$ $(36.0987\ \angle -80.7564^0)$
Post-fault network			
1	$0.5005 - j7.7897$ $(7.8058\ \angle -86.3237^0)$	$0.0 + j0.0$	$-0.2216 + j7.6291$ $(7.6323\ \angle 91.6638^0)$
2	$0.0 + j0.0$	$0.1591 - j6.1168$ $(6.1189\ \angle -88.5101^0)$	$-0.0901 + j6.0975$ $(6.0982\ \angle 90.8466^0)$
3	$-0.2216 + j7.6291$ $(7.6323\ \angle 91.6638^0)$	$-0.0901 + j6.0975$ $(6.0982\ \angle 90.8466^0)$	$1.3927 - j13.8728$ $(13.9426\angle -84.2672^0)$

contd.... P/6

EEE 411

Course Outcomes of EEE 411: Power System II	
COs	**CO Statement**
CO1	**Explain** the transient stability, voltage stability and frequency stability by **applying** the knowledge of power system and rotor dynamics.
CO2	**Analyse** the techniques economic operation of power system with and without transmission loss.
CO3	At the end of the course the students will be able to **design** a stability cogitated power system by satisfying necessary requirements
CO4	At the end of the course the students will be able to **investigate** the techniques for voltage improvement, power system augmentation and power quality improvement.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **EEE 417** (Random signals and processes)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

The corresponding Course Outcomes **(COs)** of each part of Questions 1 and 5 are mentioned on the right most column. The **COs** of the Course are mentioned at the end of the question paper.

SECTION – A

There are **FOUR** questions in this section. Answer to **Question no. 1 is Compulsory**. Answer any **TWO** questions from Questions 2-4.

1. (a) Let $X(t) = A(t)\cos(\omega_0 t + \theta)$ where A(t) is a WSS process and $\theta \sim u(0, 2\pi)$. Now, $Y(t) = A(t)\cos\{(\omega_0 + \omega_1)t + \theta\}$ where ω_0 and ω_1 are arbitrary constants. Let $Z(t) = X(t) + Y(t)$. Is Z(t) WSS? Justify your answer. **(20)** (CO4)

   (b) Let $Y(t) = X(t) + ax(t - d)$ where a and d are arbitrary factors. Find the cross-correlation function R_{XY}, cross-power spectral density S_{XY} and power spectral density of Y(t). Are X and Y orthogonal and uncorrelated? Here, $R_{xx}(\tau) = 10\, e^{-2|\tau|}$. Justify your answer. **(15)** (CO5)

2. (a) A linear system has the input X(t) where X(t) is a white noise that has a mean-square value of 1.2 V^2/Hz. The transfer function of the system is given by: **(20)**

$$H(\omega) = \frac{\omega}{\omega^2 + 15\omega + 40}$$

   The output Y(t) is sampled with a sampling period of 15s. Find the power spectral density of Y(n), the sampled version of Y(t). What is the average power of Y(t) and Y(n). Comment on your result.

   (b) Find the mean and autocorrelation of MA(3) process given by: **(15)**

$$Y(n) = W(n) + 0.5W(n-1) - 0.2W(n-2) + 0.3W(n-3)$$

   Assume that W(n) is a zero-mean white noise process.

3. (a) A deterministic signal x(t) is corrupted with noise n(t) where $R_{NN}(\tau) = 20e^{-\alpha|\tau|}$, α being arbitrary constant. Develop a filter which will maximize the SNR at the output of the filter at $t = t_0$. You may ignore causality of the filter. **(20)**

   (b) A random process is given by: X(t) = A where $A \sim u(-1, 1)$. **(15)**
   Is X(t) mean-ergodic and correlation ergodic? Justify.

4. (a) Let X ~ Binomial (n, p). The moment generating function is given by: **(20)**

$$M_x(s) = (pe^s + q)^n \ .$$

   Evaluate the upper bound on $P(X \geq \alpha n)$ where $P = \frac{1}{2}$ and $\alpha = \frac{1}{3}$, employing Markov, Chebychev and Chernoff inequalities. Compare your results.

   (b) State and prove the weak law of large numbers. Comment on it's limitation. **(15)**

Contd P/2

EEE 417

SECTION - B

There are FOUR questions in this section. Answer to Question no 5 is compulsory. Answer any 2 questions from Questions 6-8.

5. (a) What are the three axioms of probability? Prove, $\Pr(\bar{A}) = 1 - \Pr(A)$ using these axioms. **(10)** (CO1)

(b) A particular random voltage, V can be represented by a Rayleigh random variable, such as, **(13)** (CO2)

$$f_V(v) = \frac{2}{5} v e^{\frac{v^2}{5}} u(v)$$

Calculate the average power across a 1 Ω resistor if the voltage V is imposed on it.

(c) Calculate the mean, variance, coefficient of skewness, and coefficient of kurtosis for a random variable X. The PDF of X is: **(12)** (CO3)

$$f_X(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2}, \qquad x \in \mathbb{R}$$

6 (a) The PDF of the time T it takes a bank teller to serve a customer is defined by **(12)**

$$f_T(t) = \begin{cases} \frac{1}{5} & 3 \le t \le 8 \\ 0 & \text{Otherwise} \end{cases}$$

Calculate the probability of the customer being served in less than 6 minutes.

(b) The CDF of a random variable Y is defined by **(10)**

$$f_Y(y) = \begin{cases} 0 & y < 0 \\ K\{1 - e^{-4y}\} & y \ge 0 \end{cases}$$

Find the value of K for which this CDF is valid.

(c) Assume that automobile arrivals at a gasoline station are Poisson distributed and occur at an average rate 50/hour. The station has only one gasoline pump. If all automobiles are assumed to require 90 seconds to obtain fuel, what is the probability that a waiting line will occur at the station? **(13)**

7 (a) For a certain binary nonsymmetric channel as shown in Fig. 7(a), it is given that $p_{y|x}(0|1) = 0.3$ and $p_{y|x}(1|0) = 0.2$ where x is the transmitted bit and y is the received bit. If $p_x(0) = 0.45$, determine $p_y(0)$, $p_y(1)$, p(error), $p_{x|y}(0|1)$, and $p_{x|y}(1|0)$. **(18)**

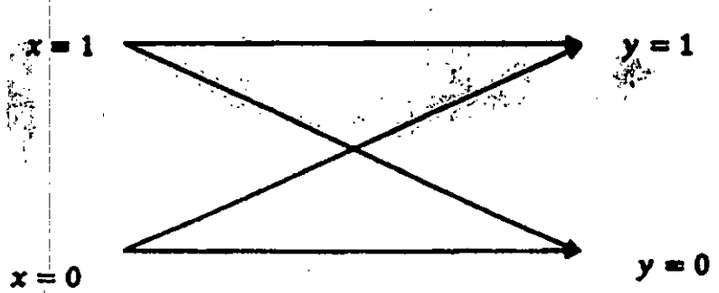

Fig for Q 7(a)

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(b) A random variable X is uniformly distributed over the range $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$. Find the density function of $g(X) = a\tan(X)$ where $a > 0$. **(17)**

8. (a) A pair of random variables has a joint PDF defined by **(15)**

$$f_{X,Y}(x,y) = \begin{cases} \frac{x^2+y^2}{8\pi} & x^2+y^2 < b \\ 0 & \text{Elsewhere} \end{cases}$$

(i) Find the constant b so that this is a valid density function.

(ii) Are X and Y independent?

(b) A pair of random variables has a joint PDF defined by **(20)**

$$f_{X,Y}(x,y) = \begin{cases} 25e^{-5y} & 0 < x < 0.2, y > 0 \\ 0 & \text{otherwise} \end{cases}$$

(i) Find the marginal PDFs of X and Y.

(ii) Are X and Y uncorrelated? Comment on the independence of X and Y.

(iii) Find P(X>Y)

Course Outcomes of EEE 417

CO No.	CO Statement	Corresponding PO(s)*
CO1	Recall the basics of probability, employ the concept of Bernoulli trials to estimate outcomes repeated experiments and evaluation of the reliability of electrical engineering systems	PO(a), PO(b)
CO2	Recognize uni-variate and bi-variate random variables, analyze their properties and perform transformations of uni- and bi-variate random variables and interpret the outcomes	PO(a), PO(b)
CO3	Estimate the moments of uni-rand bi-random variables, and employ to obtain bounds (inequalities) with applications and interpret the outcomes	PO(a), PO(b)
CO4	Identify random processes and analyze their properties including interpretation and estimation of stationarity and ergodicity	PO(a), PO(b)
CO5	Analyze and interpret the output and input-output relation of electrical engineering systems for given random inputs; perform statistical modeling of electrical engineering signals and systems and estimate relevant parameters.	PO(a), PO(b)

Contd P/4

EEE 417

Appendix 2 – Normal Distribution Table

TABLE 5.1: AREA $\Phi(x)$ UNDER THE STANDARD NORMAL CURVE TO THE LEFT OF X

X	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9916
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9987	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990
3.1	.9990	.9991	.9991	.9991	.9992	.9992	.9992	.9992	.9993	.9993
3.2	.9993	.9993	.9994	.9994	.9994	.9994	.9994	.9995	.9995	.9995
3.3	.9995	.9995	.9995	.9996	.9996	.9996	.9996	.9996	.9996	.9997
3.4	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9997	.9998

L-4/T-1/EEE **Date: 04/05/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B.Sc. Engineering Examinations 2022-2023

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

The corresponding Couse Outcomes (COs) of each part of Question 1 and 5 are mentioned on the right most column.

SECTION – A

There are FOUR questions in this section. Answer to Question No. 1 is compulsory.

Answer any TWO questions from Questions 2-4.

1. (a) Consider the simple function: **(12)**

$$y = \begin{cases} x^2 & 0 \le x \le 1 \\ 0 & \text{otherwise} \end{cases}$$ (CO4)

Sketch the closest approximation of the signal $x(t)$ in v_j for j = 0, 1, 2, where v_j represent the Haar scaling spaces. Can you obtain the wavelet series expansion of $x(t)$ from these closet signals?

(b) Consider a simple 3 × 4 image: **(12)**

0 1 0 1 (CO5)

1 0 0 0

2 2 2 1

Compute the Lempel-Ziv compression of the image. Show the image data, compressed output and associated dictionary at each step of the compression process.

(c) Design an invisible watermarking system based on the discrete cosine transform (DCT). What is the advantage of DCT bases method over LSB watermarking technique? **(11)** (CO6)

2. (a) Consider a linear, position-invariant image degradation system with impulse response **(12)**

$$h(x-\alpha, y-\beta) = e^{-\left[(x-\alpha)^2+(y-\beta)^2\right]}$$

Suppose that the input to the system is a binary image consisting of a white vertical line of infinitesimal width located at x = a, on a black background. Such an image can be modeled as $f(x,y) = \delta(x-a)$, where δ is an impulse. Assuming negligible noise, determine the output image, g(x,y)?

Contd..... P/2

EEE 447

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

(b)What are the different ways to estimate the degradation function for image restoration? The image shown in Fig. for Q2(b) is blurred, 2-D projection of a volumetric rendition of a heart. It is known that each of the cross hairs on the right bottom part of the image was (before blurring) 3 pixels wide, 30 pixels long, and had an intensity value of 255. Which method would you use to obtain the blurring function? Briefly describe the process. **(11)**

Fig. for Q 2(b)

(c) An image has been corrupted by additive white Gaussian noise and motion blur. Your goal is to minimize the expected mean squared error between the original image and the restored one. Which filter would you apply to restore the image? Write the expression of the filter in the frequency domain. What modification can be made if the power spectrum of the image is not known? **(12)**

3. (a) Determine the Walsh-Hadamard and Slant transforms of the 1-D function, $f = [2\ 3\ 4\ 5]^T$. The transformation matrices are given as follows: **(12)**

$$\mathbf{A}_{W} = \frac{1}{\sqrt{4}}\mathbf{H}_{W} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & 1 & -1 & -1 \\ 1 & -1 & -1 & 1 \\ 1 & -1 & 1 & -1 \end{bmatrix} \qquad \mathbf{A}_{SI} = \frac{1}{\sqrt{4}}\mathbf{S}_{4} = \frac{1}{2}\begin{bmatrix} 1 & 1 & 1 & 1 \\ \frac{3}{\sqrt{5}} & \frac{1}{\sqrt{5}} & \frac{-1}{\sqrt{5}} & \frac{-3}{\sqrt{5}} \\ 1 & -1 & -1 & 1 \\ \frac{1}{\sqrt{5}} & \frac{-3}{\sqrt{5}} & \frac{3}{\sqrt{5}} & \frac{-1}{\sqrt{5}} \end{bmatrix}$$

Which transformation gives more compact representation of the given 1-D function, f, in the transform domain? Why?

(b) If we think of the scaling and wavelet coefficients, sj,n and wj,n, at scale j as a discrete time sequence, how can you determine the scaling and wavelet coefficients at scale j-1? Draw the architecture diagram in terms of signal processing blocks. **(11)**

(c) Explain wavelet decomposition of 2-D functions such as images with separable 2-D scaling and wavelet function. How wavelet transformation can be utilized for edge detection and image compression? **(12)**

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4. (a) Consider the simple 4 × 8, 8-bit image: **(15)**

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

Compute the entropy of the image. Compress the image using Huffman coding. Compute the compression achieved and the effectiveness of the Huffman coding.

(b) Draw the block diagram of the JPEG compression technique. Why DCT is chosen as a transformation in JPEG? How can you achieve variable compression ratio in JPEG image? **(12)**

(c) What are the major difference between JPEG, JPEG-LS, JPEG-2000, and MPEG compression techniques? **(8)**

SECTION – B

There are FOUR questions in this section. Answer to Question No. 5 is compulsory. Answer any TWO questions from Questions 6-8.

5. (a) Show that the Fourier transform of an impulse train with period ΔT is also an impulse train, whose period is $1/\Delta T$. **(15)** (CO3)

(b) Suppose that a flat area with center at (x_0, y_0) is illuminated by a light source with intensity distribution **(10)**

$$i(x,y) = K\, exp\left(-(x-x_0)^2 - (y-y_0)^2\right) \quad \text{(CO1)}$$

Assume for simplicity hat the reflectance of the area is constant and equal to 1.0, and let K = 255. If the resulting image is digitized with k bits of intensity resolution, and the eye can detect an abrupt change of eight shades of intensity between adjacent pixels, what value of k will case visible false contouring?

(c) Describe in detail how the second derivative can be used for image sharpening. **(10)** (CO2)

6. (a) With necessary diagrams/flow-charts, briefly explain the functionalities of the different components of an image processing system. **(20)**

(b) Considering the two image subsets, S_1 and S_2, shown in Fig. for Q. 6(b). For $V = \{1\}$ determine whether these two subsets are (i) 4-adjacent, (ii) 8-adjacent, or (iii) m-adjacent. **(15)**

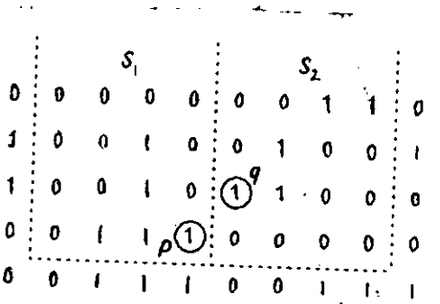


Fig. for Q. 6(b)

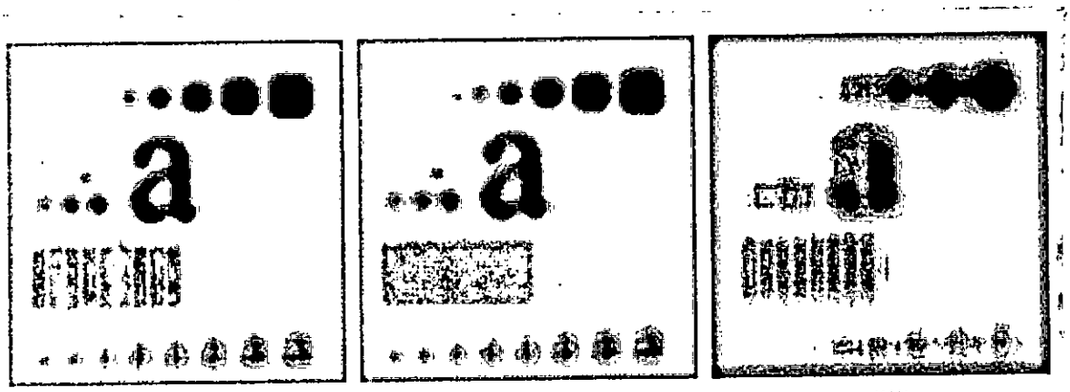
Contd..... P/4

EEE 447

7. (a) Show that the computational advantages of the Fast Fourier Transform algorithm can be written as $c(n)=\frac{2^n}{n}$, where n is a positive integer. **(20)**

(b) Develop a procedure for computing the median of an $n \times n$ neighborhood. How can the median be updated as the center of the neighborhood is moved from pixel to pixel? **(15)**

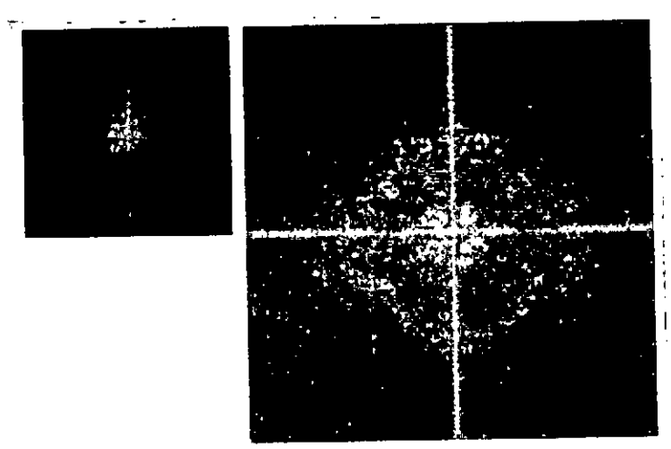
8. (a) The three images shown in Fig. for Q. 8(a) were blurred using square averaging masks of sizes n = 23, 25, and 45, respectively. The vertical bars on the left lower part of images (i) and (iii) are blurred, but a clear separation exists between them. However, the bars have merged in image (ii), despite the mask that produced this image is significantly smaller than the mask that produced image (iii). What do you think is the reason for this? Explain with necessary diagrams. **(20)**



(i) (ii) (iii)

Fig. for Q. 8(a)

(b) The two Fourier spectra shown in Fig. for Q. 8(b) are of the same image. The spectrum on the left corresponds to the original image, and the spectrum on the right was obtained after the image was padded with zeros. Explain the significant increase in signal strength along the vertical and horizontal axes of the spectrum shown on the right. **(15)**



(i) (ii)

Fig. for Q. 8(b)

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2022-2023

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

The corresponding Course Outcomes **(COs)** of each part of Questions 1 and 5 are mentioned on the right most column. The **COs** of the Course are mentioned at the end of the question paper.

SECTION – A

There are **FOUR** questions in this section. Answer to **Question no. 1 is Compulsory.**
Answer any **TWO** questions from Questions 2-4.

1. (a) Differentiate between depletion mode and enhancement mode JFET devices. **(7)** (CO2)

   (b) An n-channel GaAs MESFET at T = 300 K has the following parameters: φ_{Bn} = 0.90 V, $N_d = 4\times10^{16}$ cm^{-3}, μ_n = 7500 cm^2/V-s, a = 0.30 μm, W = 5 μm, and L = 1.2 μm. Calculate the cutoff frequency using (i) the constant mobility model and (ii) the saturation velocity model. Given $\varepsilon_r = 13.1$ and $V_s = 10^7$ cm/s. **(10)** (CO1)

   (c) The Schottky barrier height, φ_{Bn} of a metal-n-silicon MESFET is 0.8 V. The channel thickness dimension is a = 0.4 μm and the channel doping is $N_d = 2\times10^{16}$ cm^{-3}, T = 300 K. (i) For this device, calculate V_{bi}, V_{po}, V_T and V_{DS} (sat) for V_{GS} = -1 V (ii) What concentration of impurity atoms must be added to the channel so that V_{po} = 4.5 V. Given $N_c = 2.8\times10^{19}$ cm^{-3} and ε_r = 11.7. **(18)** (CO3)

2. (a) What is the role of critical thickness as used in the growth of compound semiconductors? **(9)**

   (b) What are the advantages and disadvantages of abrupt and graded heterojunctions? **(10)**

   (c) Draw band diagrams of ideal nP and pP hetejojunctions in thermal equilibrium. Make assumptions as needed. **(16)**

3. (a) What are the uses of compound semiconductors in electronics and optoelectronics? **(6)**

   (b) Derive the current voltage relationship for a metal-semiconductor junction. **(12)**

   (c) A metal-semiconductor junction is formed between a metal with a work function of 4.3 eV and p-type silicon with an electron affinity of 4.0 eV. The acceptor doping concentration in the silicon is $N_a = 5\times10^{16}$ cm^{-3}. Assume T = 300 K. (i) Sketch the thermal equilibrium energy-band diagram. (ii) Determine the height of the Schottky barrier. (iii) Sketch the energy-band diagram with an applied reverse-biased voltage of V_R = 3V. (iv) Sketch the energy-band diagram with an applied forward-bias voltage of V_a = 0.25 V. Given $N_c = 2.8\times10^{19}$ cm^{-3} and $N_v = 1.04\times10^{19}$ cm^{-3}. **(17)**

Contd P/2

EEE 455

4. (a) Write a short note on Kirk effect. Derive the expressions for current induced base width, W_{CIB} and critical collector current, J_K as used in Kirk effect. **(12)**

(b) A uniformly doped silicon pnp bipolar transistor is to be designed with $N_E = 10^{19}$ cm^{-3} and $N_C = 10^{16}$ cm^{-3}. The metallurgical base width is 0.75 μm. Determine the minimum base doping so that the minimum punch through voltage is no less than 25 V. **(13)**

(c) For avalanche breakdown in BJT, show that $BV_{CEO} = \frac{BV_{CBO}}{\sqrt[n]{\beta}}$, where the symbols used have their usual meanings. Why is BV_{CEO} less than BV_{CBO}? **(10)**

SECTION – B

There are **FOUR** questions in this section. Answer to **Question no. 5 is Compulsory**.

Answer any **TWO** questions from Questions 6-8.

5. (a) A resonant tunneling diode (RTD) is a type of semiconductor device that exploits the quantum mechanical phenomenon of tunneling to produce negative differential resistance. This means that under certain conditions, an increase in voltage across the device leads to a decrease in current, a behavior that is contrary to most electronic components. The key feature of an RTD is its quantum well structure. This structure consists of a thin layer of semiconductor material (the well) sandwiched between two barriers. The thickness of these barriers is such that electrons can tunnel through them quantum mechanically. Now design a RTD using AlGaAs/GaAs/AlGaAs quantum well structure and draw the energy band diagram of the structure in thermal equilibrium. **(15)**

(CO3)

(b) With necessary energy band diagrams, explain I-V characteristics of the RTD under different biasing conditions. **(10)**

(CO2)

(c) Discuss Negative Differential Resistance effect in RTD. Define Current Peak to Valley Ratio and how this ratio can be changed/designed in a RTD. **(10)**

(CO1)

6. (a) Discuss the merits of HBT over conventional BJT. **(10)**

(b) Draw the (i) cross sectional view of a typical AlGaAs/GaAs HBT (ii) Corresponding energy band diagram (iii) doping profile. **(15)**

(c) Draw the energy band diagram of Si/SiGe HBT and discuss its key features. **(10)**

Contd P/3

EEE 455

7. (a) Draw the basic Ebers Moll equivalent circuit of a HEMT and derive the equation for $V_{CE(sat)}$ as a function of thermal voltage and terminal currents. **(20)**

   (b) In a conventional AlGaAs/GaAs HEMT, consider N $Al_{0.3}Ga_{0.7}As$ doped to 10^{18} cm^{-3} and having a thickness of 50 nm. Assume an undoped spacer layer of 2 nm. Let ϕ_B = 0.85 V and $\frac{\Delta E_c}{q} = 0.22\,V$. The relative dielectric constant of AlGaAs is 12.2. Calculate the threshold voltage of the HEMT and channel electron concentration at Vg = 0 V. **(15)**

8. (a) Using the Gummel Poon Model derive that the current density of a BJT is given by $J_n = \frac{-eD_n n_i^2 e^{(\frac{V_{BE}}{V_t})}}{\int_0^{x_B} p(x)dx}$. Here the symbols have the usual meaning. **(20)**

   (b) Discuss the advantages of Gummel Poon model over the Ebers Mool model. **(15)**

Course Outcomes of EEE 455

COs	CO statement
CO1	Implement the physics-based knowledge to solve problems relevant to compound semiconductor materials and heterostructure devices
CO2	Analyses the operation of heterostructure devices based on the operational principle
CO3	Design electronic devices based on compound semiconductors

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B.Sc. Engineering Examinations 2022-2023

Sub: **EEE 463 (Introduction to Nanotechnology and Nanoelectronics)**

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

The corresponding Couse Outcomes (COs) of each part of Question 1 and 5 are mentioned on the right most column. The COs of the course are mentioned at the end of the question paper.

SECTION – A

There are FOUR questions in this section. Answer to Question No. 1 is compulsory.

Answer any TWO questions from Questions 2-4.

Assume any parameter, otherwise not mentioned, that you may need and mention justification.

1. (a) Explain the process of image formation in Transmission Electron Microscope. **(17)**
How does optical resolution get improved in TEM? (CO1)

(b) From the figures of Q. No. 1(b), explain which TEM image is dark-field image and which one is bright-field? Explain how do these images form with proper diagrams within a TEM. **(18)**

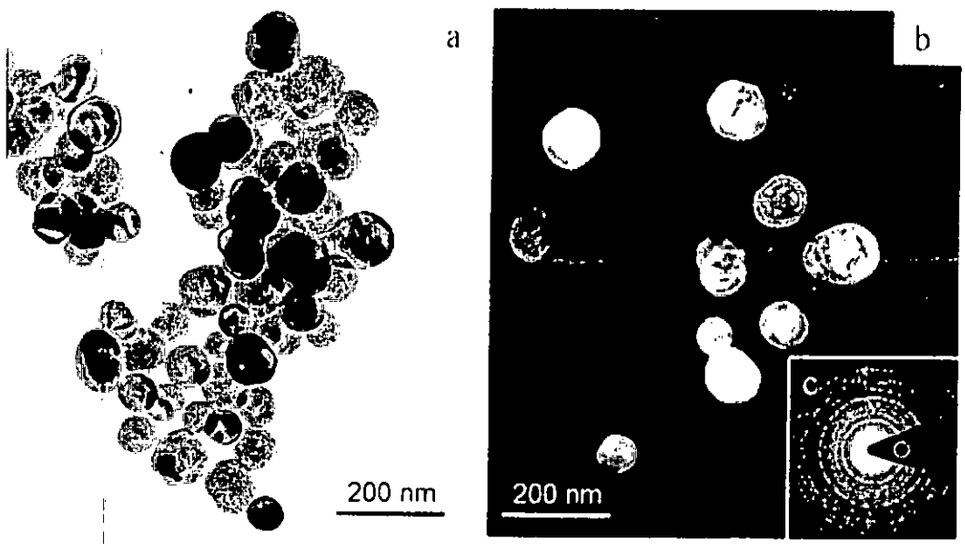


Figure for Q. No. 1(b)

2. (a) "The AFM is an engineering extension of the idea of STM" - explain this statement in detail with proper diagrams of AFM and STM. **(25)**

(b) What is HRTEM? What are the differences between RHEED and Auger Electron Spectroscopy for nano-object characterization? **(10)**

Contd..... P/2

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3. (a) Explain the idea of self-assembly and its importance for bottom-up assembly. Write in detail the technological applications of self-assembled monolayers (SAM). **(22)**

   (b) Shortly describe the Langmuir-Blodgett method of SAM fabrication. **(13)**

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

   i) Tissue engineering with nanotechnology

   ii) Nano-cosmeceuticals Industry

   iii) Nanotechnology Enhanced Energy Storage

   iv) Green Agriculture and Nanotechnology

   v) Molecular Beam Epitaxy

SECTION – B

There are FOUR questions in this section. Answer to Question No. 5 is compulsory. Answer any TWO questions from Questions 6-8.

5. Quantum wave function can penetrate through a finite potential barrier, which is known as tunneling. The concept of tunneling has been used in many nano-devices, Esaki diode being one of them. Leo Esaki was awarded Nobel Prize in 1973 for his contribution in electron tunneling devices.

   (a) For a potential barrier with V(x)=0 for $x > |a/2|$, and V(x)=0.3 eV for $x < |a/2|$, calculate the tunneling probability for E=0, 0.3 and 0.5eV. Take the value $a = 5nm$ and use the effective mass of electron in GaAs, $m^* = 6\times10^{-32}\,kg$. **(18)** (CO2)

   (b) Propose a way to fabricate Esaki diode. Briefly explain how Esaki diode works. **(17)** (CO1)

6. (a) With the help of necessary band diagrams, describe the operation principles of resonant tunneling diodes and resonant tunneling transistors. **(20)**

   (b) What are Quantum Dots? Write some application of quantum dots in optoelectronic devices. **(15)**

7. (a) Explain the statement - "nanotechnology is the imitation of biology in a dry environment" - with proper reasoning and natural explanations. **(14)**

   (b) What is Protein Engineering? How can drug delivery be revolutionized through nanotechnology? **(12)**

   (c) Briefly describe the potentials of DNA nanomechanical devices - nano-robots capable of controlled movement. **(9)**

8. (a) What is the ten-step process for top-down fabrication? Briefly describe with proper diagrams. **(20)**

   (b) With proper diagram, explain the function of any one technique for dry ion etching. **(15)**

Contd..... P/3

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Appendix

For the potential barrier shown in Fig. for Appendix-1,
Tunneling probability is given by:

$$T = \left[1 + \left(\frac{k^2 + \gamma^2}{k\gamma}\right)^2 \sinh^2(2\gamma a)\right]^{-1} \qquad for\ V_o \geq E$$

and

$$T = \left[1 + \left(\frac{k^2 - k'^2}{2kk'}\right)^2 \sin^2(2k'a)\right]^{-1} \qquad for\ V_o < E$$

where $k = \sqrt{2m^*E/\hbar^2}$, $k' = \sqrt{2m^*(E - V_o)/\hbar^2}$ and $\gamma = \sqrt{2m^*(V_o - E)/\hbar^2}$

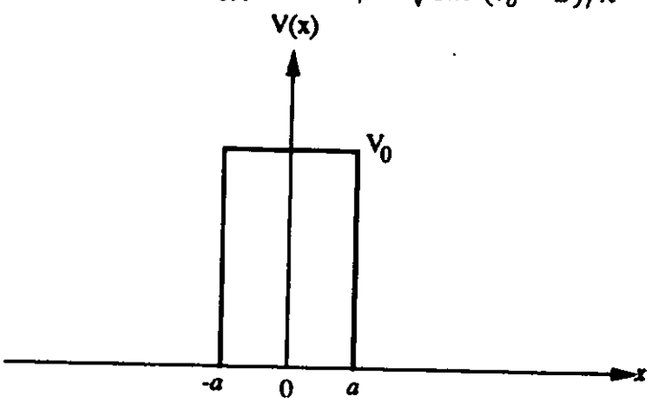


Fig. for Appendix-1

Course Outcomes of EEE 463

CO No.	CO Statement
1	Explain the theories of nano dimension, nano tools, top-down and bottom-up processes and operation of some nano-devices.
2	Analyse nano-electronic processes, tools, and devices by applying concepts of nano principles.

19/05/2024

L-4/T-1/EEE Date: ~~28/04/2024~~

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **EEE 465** (Analog Integrated Circuits and Design)

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks

The corresponding Course Outcomes (COs) of each part of Question 1 and 5 are mentioned on the right most column. The COs of the Course are mentioned at the end of the question paper.

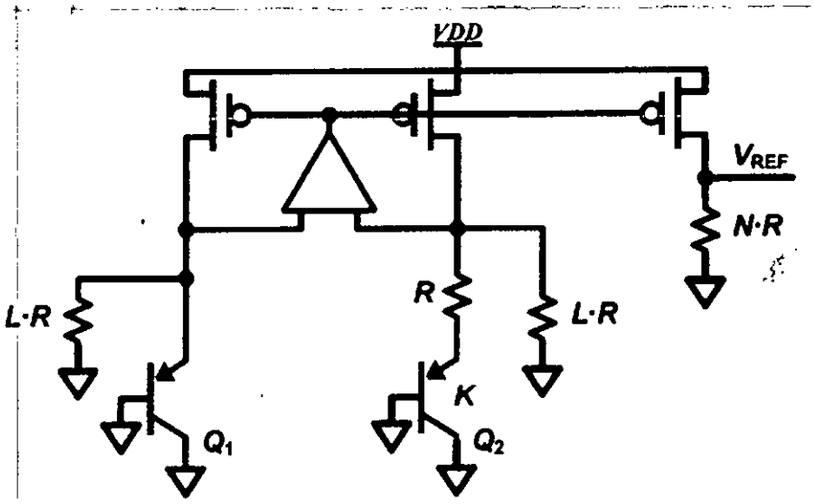
USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer to **Question No. 1 is compulsory.**

Answer any TWO questions from Questions 2-4.

1. (a) The following bandgap circuit can operate with low supply voltages. Here, K signifies the number of PNP diodes in parallel. **(4+6+6+4=20)**



Given: $\frac{\partial v_{BE}}{\partial T} = -1.5\frac{mV}{K}$, $\frac{\partial v_T}{\partial T} = 0.085\frac{mV}{K}$

$V_{BE_2} = 0.7V$ and $V_{SG} = 0.3V$.

Fig for Q 1(a)

(i) Assign positive and negative terminals on the OpAmp in the circuit to ensure proper operation. **(CO3)**

(ii) For K = 8, find value of L for which the output has zero temperature coefficient. **(CO1)**

(iii) Find value of N such that $V_{REF} = 0.5V$. **(CO2)**

(iv) What is the minimum supply voltage for which the reference will operate properly? **(CO3)**

Contd P/2

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Contd... Q. No. 1

(b) Design an LDO with the following target specifications: (15) (CO3)

- Input voltage: 1.5 V
- Output voltage: 1 V
- Maximum output current: 10 mA
- Power supply rejection> 30 dB up to 10 MHz
- Available V_{REF} = 0.9 V

Estimate the following parameters of a PMOS LDO using the TSMC 180 nm as shown in Fig. for Q 1(b):

(i) Width of the PMOS,
(ii) values of R_1 and R_2,
(iii) low frequency gain and unity gain bandwidth of the OpAmp.

Technology	180 nm
V_{DD} [V]	1.8
$\mu_n C_{ox}$ [$\mu A/V^2$]	170
$\mu_p C_{ox}$ [$\mu A/V^2$]	36
V_{tn} [V]	0.46
V_{tp} [V]	-0.46

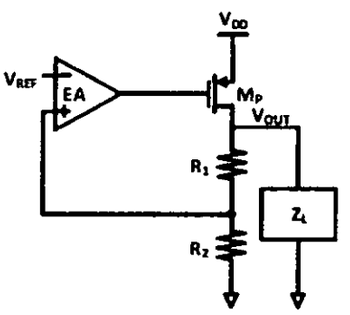

Fig for Q 1(b)

2. (a) Fig. for Q. 2(a) is the picture of Miller-compensated two-stage amplifier. **(5+10+5=20)**

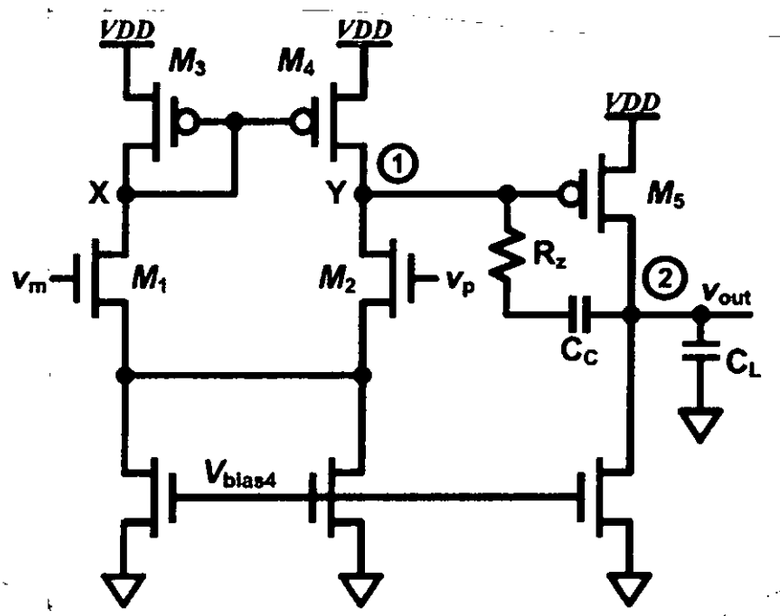

Fig for Q 2(a)

Contd P/3

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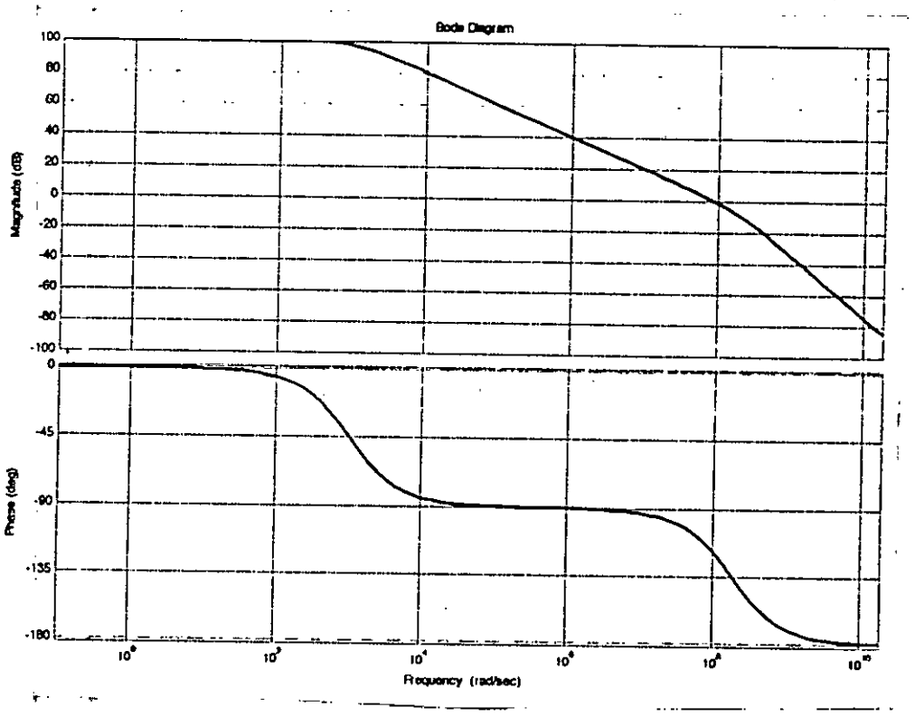
Contd... Q. No. 2

(i) For what value of R_z, the RHP zero is pushed to ∞

(ii) The open-loop frequency response for the amplifier is shown below. Label the gain and phase crossover points (GX and PX). Find the phase and gain margin (ϕ_M and GM), unity gain frequency (fun), and the dominant pole of the OpAmp.



(iii) Will this OpAmp be stable in closed loop? Why?

(b) The V_{in} signal shown in Fig for Q 2(b) is being applied to the input terminal of the circuit shown in the same figure. Draw the corresponding output wave form. **(15)**

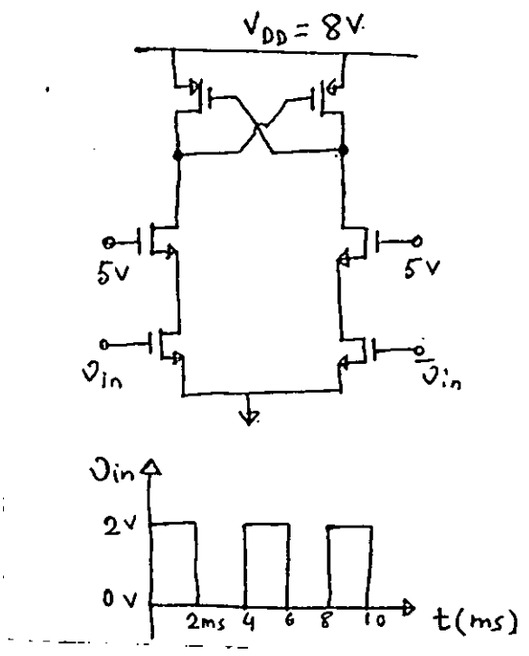


Fig. for Q 2(b)

Contd P/4

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3. (a) Draw a circuit to generate the bias voltage V_b in the single stage OpAmp shown in Fig. for 3(a) such that the minimum value for the V_{out} is $2\Delta V$ where $\Delta V = \sqrt{\frac{I_{SS}}{\mu_n C_{ox}\left(\frac{W}{L}\right)}}$ and $\left(\frac{W}{L}\right)_{3,4,5,6} = \left(\frac{W}{L}\right)$. Ignore the body effect. **(15)**

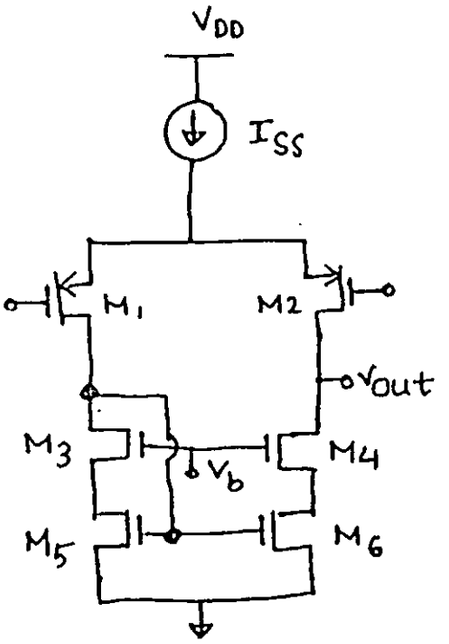

Fig. for Q 3(a)

(b) If the current source I_{SS} is realized by a p-MOSFET find the input common mode range voltage. **(10)**

(c) Find out the approximate differential small signal gain of the OpAmp in terms of g_m and r_o of the transistors. **(10)**

4. (a) Find an expression for the transconductance of the circuit shown in Fig. for Q 4(a) as a function of g_{m1}, g_{m2}, g_{m3}, r_{o1}, r_{o2}, r_{o3} and R_s. **(15)**

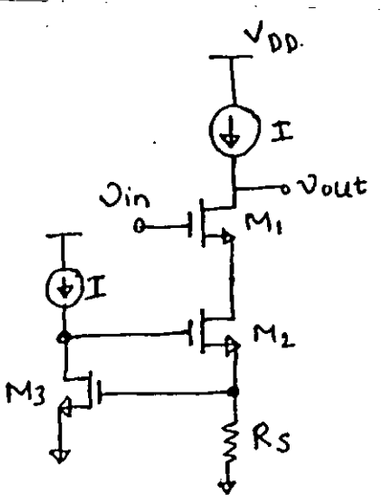

Fig. for Q 4(a)

Contd P/5

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Contd... Q. No. 4

(b) Which of the Differential amplifiers shown in Fig. for Q. 4(b) has better CMRR and why? Estimate the expressions for CMRR for both circuits **(20)**

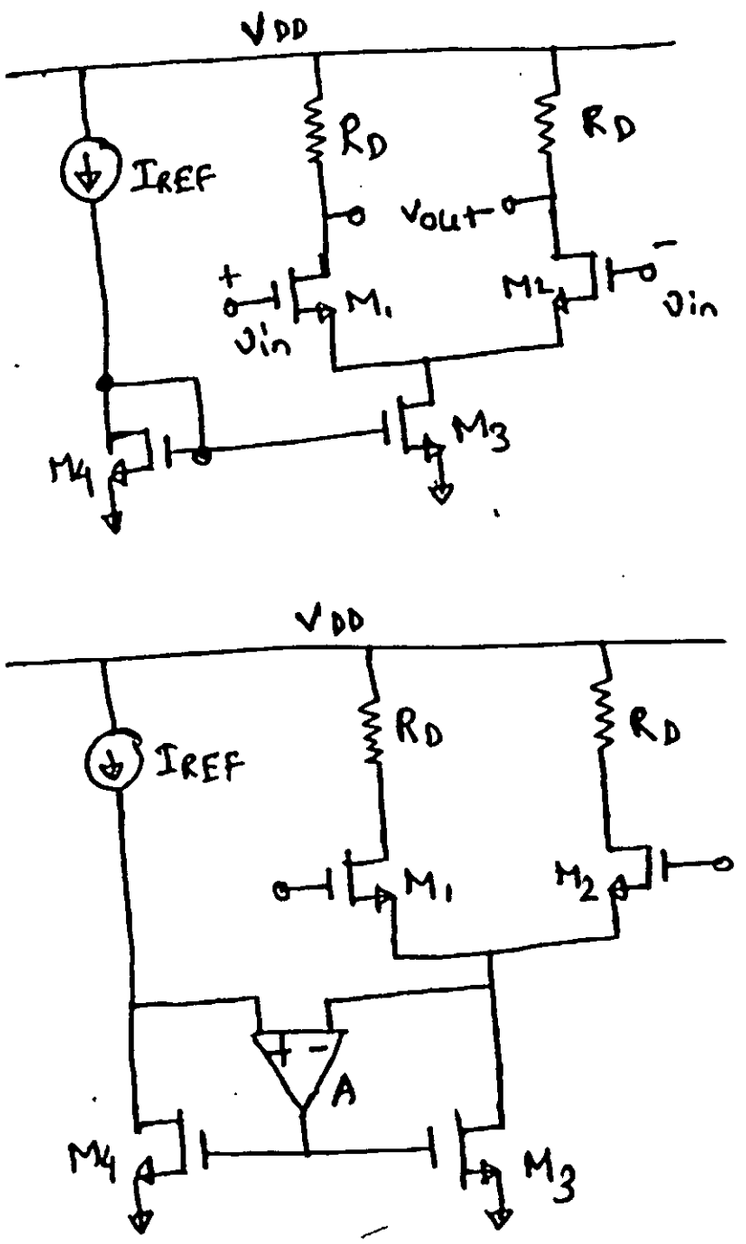

Fig. for Q 4(b)

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SECTION – B

There are **FOUR** questions in this section. Answer to **Question No. 5 is compulsory.**

Answer any TWO questions from Questions 6-8.

5. (a) Determine the small signal gain (A_v) and output resistance (R_{out}) of the circuit given in Fig for Q 5(a). Discuss the potential application of the circuit. **(23)** (CO2)

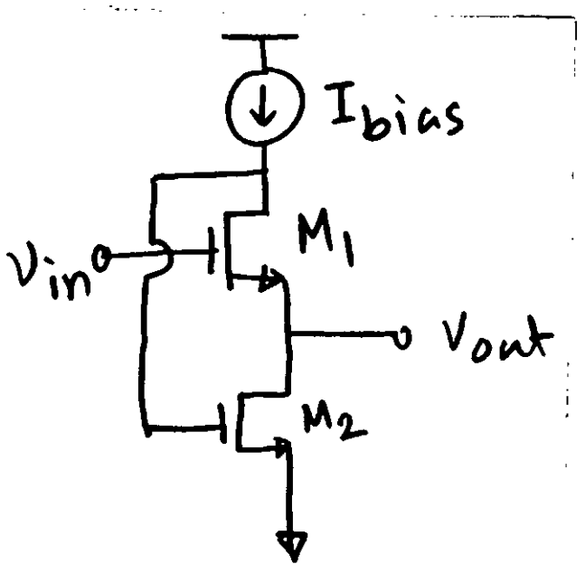

Fig for Q 5(a)

(b) For a given power level, explain mathematically why BJT has a higher gain compared to MOSFET operating in the strong inversion region. Describe how you can achieve the same gain as BJT using a MOSFET. Mention one major limitations of the modifications. **(12)** (CO1)

6. (a) Consider the current mirror circuit given in Fig. for Q 6(a). Determine the (W/L) ratio of the transistors M_4, M_5, and M_6 such that the minimum voltage swing at node X is given by $2\sqrt{\frac{I_{REF}}{\mu_n C_{ox}\left(\frac{W}{L}\right)}}$. The (W/L) ratios of the transistors M_1, M_2 and M_3 are given in the table. **(15)**

Contd P/7

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Contd... Q. No. 6

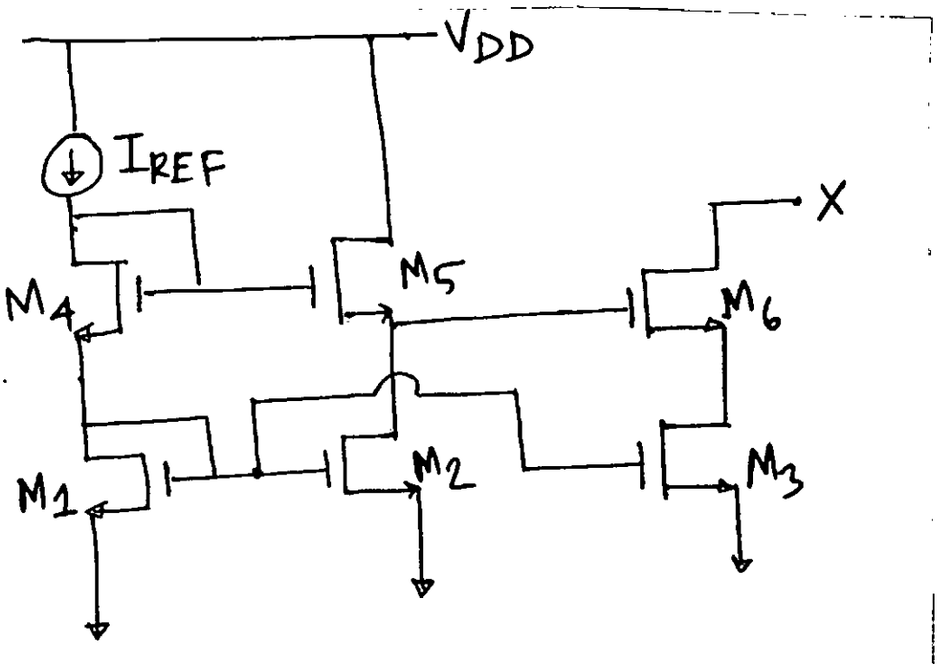
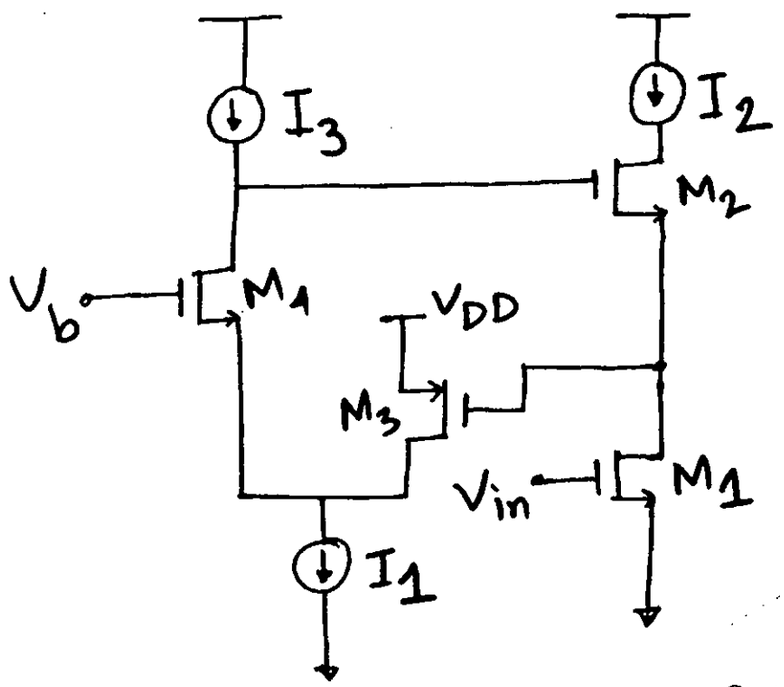


Fig. for Q 6(a)

Transistor	(W/L) ratio
M_1	10/1
M_2	10/1
M_3	10/1
M_4	?
M_5	?
M_6	?

Table for Q 6(a)

(b) Calculate the small signal voltage gain (A_v) and output resistance (R_{out}) of the circuit shown in Fig. for Q. 6(b). **(20)**



Contd P/8

Fig for Q 6(b)

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7. (a) Design the op-amp circuit such that the minimum voltage swing of the amplifier is $2\Delta V$ and small signal gain is $(g_m r_0)^3$. Here, $\Delta V = 2\sqrt{\frac{I_{REF}}{\mu_n C_{ox}\left(\frac{W}{L}\right)}}$ **(20)**

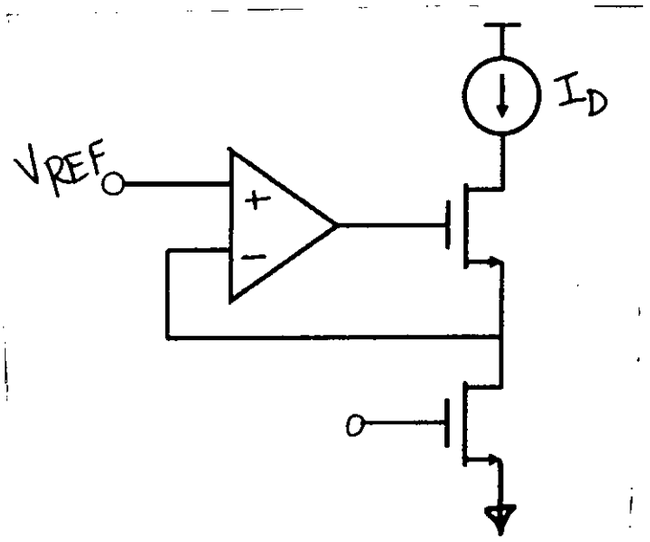

Fig for Q 7(a)

(b) Show that the small signal gain of the npn differential pair shown in Fig for Q. 7(b) is temperature independent. Assume all the MOSFETs and BJTs are identical. **(15)**

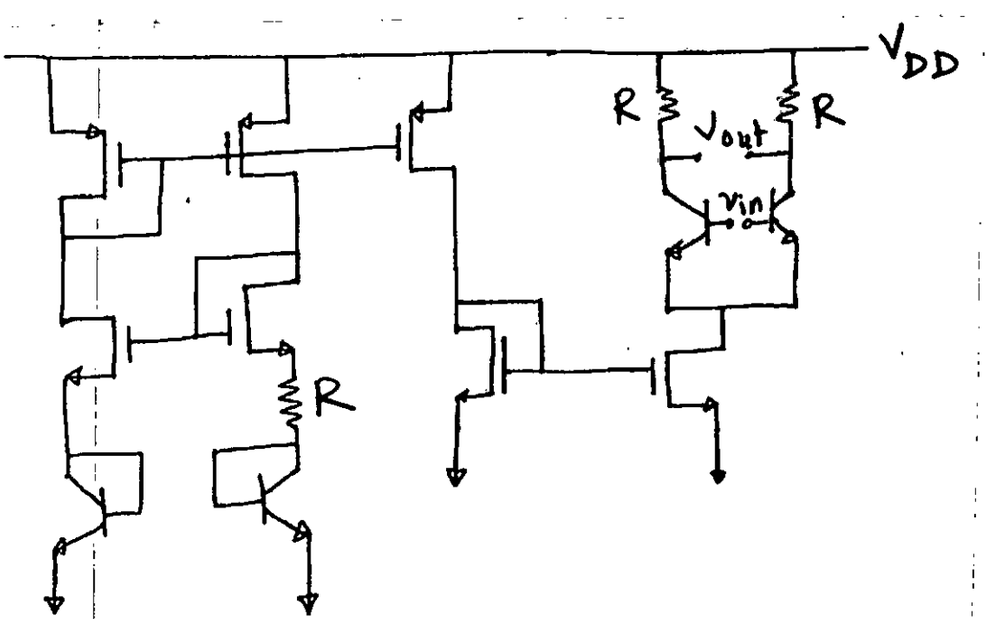

Fig. for Q 7(b)

Contd P/9

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8. (a) Consider the sampling circuit shown in Fig. for Q. 8(a). The CK signal as a function of time is also shown. Draw V_{out} as a function of time for V_{in} = 0V and +1V. **(8)**

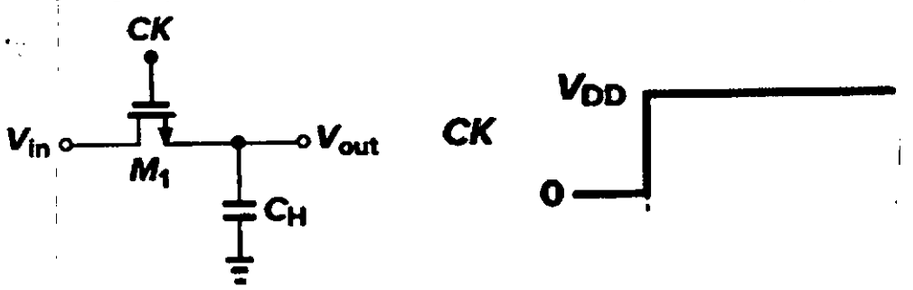

Fig. for Q. 8(a)

(b) In the circuit shown in Fig for Q 8(b), show that the current is supply independent. Explain how a start-up circuit solves the degenerate bias point issue of the circuit shown in Fig for Q 8(b). **(14)**

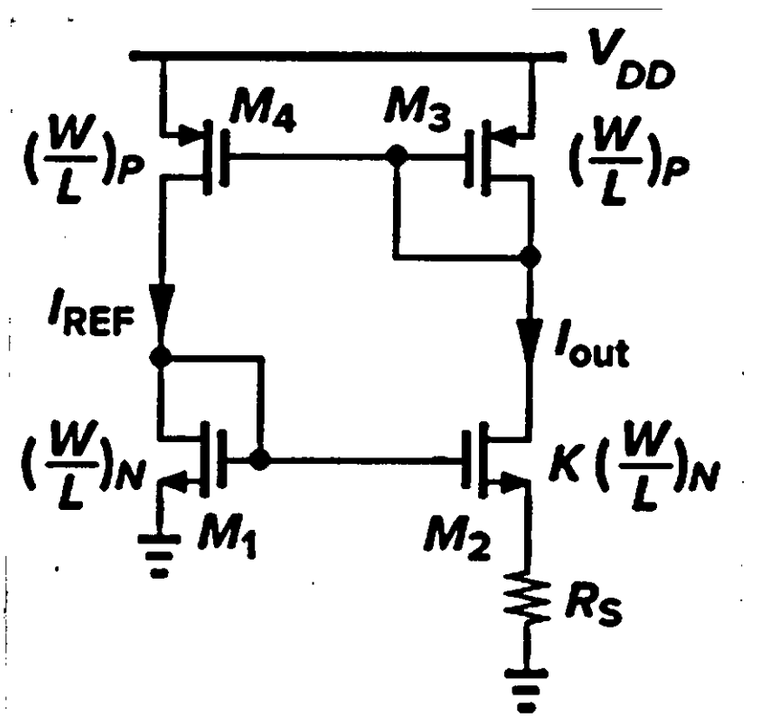

Fig. for Q. 8(b)

(c) Consider the cascode current mirror as shown in Fig for Q. 8(c). **(13)**

(i) Show that his circuit wastes one threshold voltage in the headroom. Suggest modifications to the existing circuit in order to avoid this waste.

(ii) Modify the cascode current mirror for low-voltage operations.

Contd P/10

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

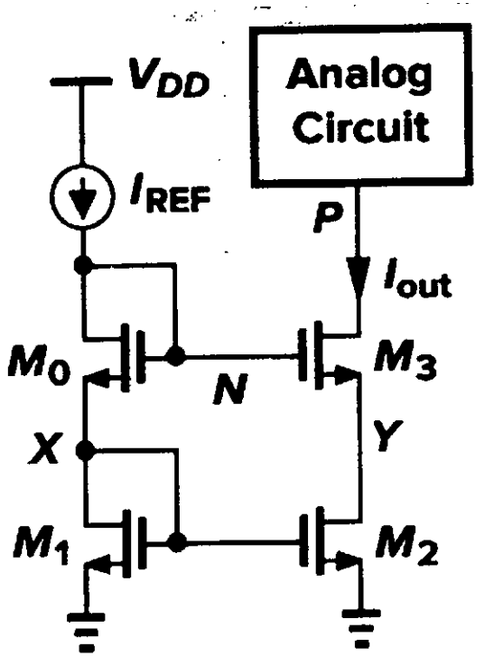

Fig. for Q. 8(c)

Course Outcomes for EEE 465

CO1	**Apply the physics-based knowledge of Semiconductor device to design circuit to process Analog signals to do useful operation.**
CO2	**Analyse the operation of integrated circuits (ICs) based on the underlying physics and control theory.**
CO3	**Design solid-state integrated circuits such that specified performance characteristics are attained.**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2022-2023

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

The corresponding Course Outcomes **(COs)** of each part of Questions 1 and 5 are mentioned on the right most column. The **COs** of the Course are mentioned at the end of the question paper.

SECTION – A

There are **FOUR** questions in this section. Answer to **Question no. 1 is Compulsory**. Answer any **TWO** questions from Questions 2-4.

1. (a) (i) Consider two system areas (Area-1: R = 0.01, D = 0.8; Area-2: R = 0.02, D = 1. All the value are in p.u. on 500 MVA base) connected by a tie line. Both areas are initially at 60 Hz and suddenly a load of 100 MW increases in Area-1. Find the change in frequency and tie line flow. **(18)** (CO3)

(ii) Suppose a tie line control scheme is implemented to make each area adjust its own generation for a change in its own load. Then find the value of ACE of each area from the control scheme.

(iii) Area-1 consists of 2 units having characteristics

Unit-1: Fuel cost, $f_1 = 0.002\ P_1^2 + 7\,P_1 + 500$ \$/hr and ramp limit 1 MW/min

Unit-2: Fuel cost, $f_2 = 0.0025\ P_1^2 + 8\,P_1 + 200$ \$/hr and ramp limit 2 MW/min

We wish to clear ACE of Area-1 to 0 in 5 mins. Is it possible if the units are to be allocated by base points and participation factors?

(b) In a 5-bus, 3-generators (at bus 3, 4 and 5) and 6-lines system, bus-5 is the slack bus. All the operational variables are within limit and at base case power flow through each line are 96 MW, -699 MW, -897 MW, -404 MW, 279 MW and 106 MW respectively. Each line can carry maximum of 1000 MW. **(12)** (CO4)

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

Find the ranking index of generation outage of 1000 MW at bus 3 if imbalance in generation is equally shared by remaining generators. Also comment on the state of the system.

(c) How does smart grid help to maintain a balance between generation and load? **(5)** (CO6)

Contd P/2

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2. (a) Three generating units operating in parallel at 60 Hz have ratings of 300, 500, and 600 MVA and have speed-droop characteristics of 5, 4 and 3% respectively and all the units have negligible LFR. Due to a change in load, an increase in system frequency of 0.3 Hz is experienced before any supplementary control action occurs. Determine the amount of the change in system load and also the amount of the change in generation of each unit to absorb the load change. **(15)**

(b) Write down the major objectives of AGC. With proper diagram explain the implementation of AGC in a certain area. Explain how ACE, telemetry and participation factor are used in your AGC logic. **(15)**

(c) How does the OPF model in alert state vary from other states? **(5)**

3. (a) In a power system OPF model, what may be the objective functions at secure, alert and emergency states? **(6)**

(b) In the power system shown in Fig. for Q. 3(b), the loads are each 1000 + j250 MVA and bus 5 is the slack bus. All the generators have a power limit of 500 MW to 1500 MW and VAR limit of -1000 MVAR to + 1000 MVAR, the line flows have a maximum limit of 1000 MW. The transformer 1-3 had 21 tap settings in step of 1% from -90% to 110% and the 200 MVAR capacitor bank at bus 2 is switchable in steps of 10 MVAR. **(20)**

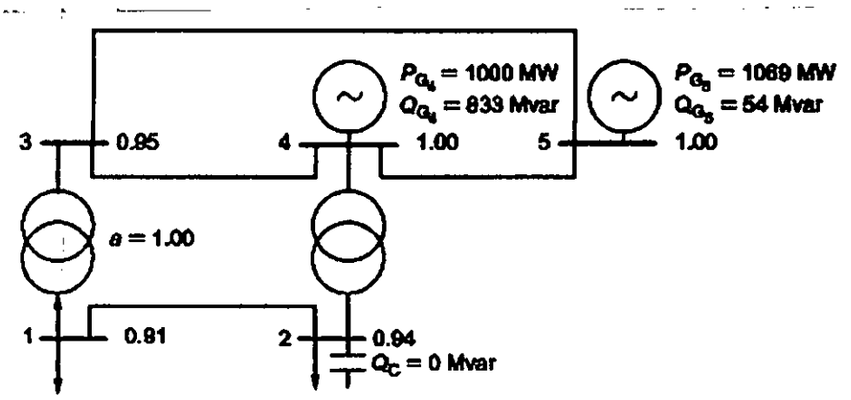

Fig. For Q.3(b)

(i) Show a complete OPF model for transmission loss minimization.

(ii) What does the Lagrange multiplier of OPF model of (i) imply? What is the expected value of this multiplier corresponding to slack bus and why?

(iii) What will be the objective function if OPF if formulated for voltage correction for above system? Given reason for your objective function.

(c) Define Security, Reliability and Resilience. Explain how they differ from each other. **(9)**

Contd P/3

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4. (a) Describe the contingency screening method based on 1-iteration of P-Q or Fast Decoupled Load Flow method. Mention its advantages over ranking index-based method. **(10)**

(b) A 3-bus power system at nominal condition using DC load model is shown in Fig. for Q. 4(b). In the system, bus 3 is slack and base values are 100 MVA and 132 KV. **(20)**

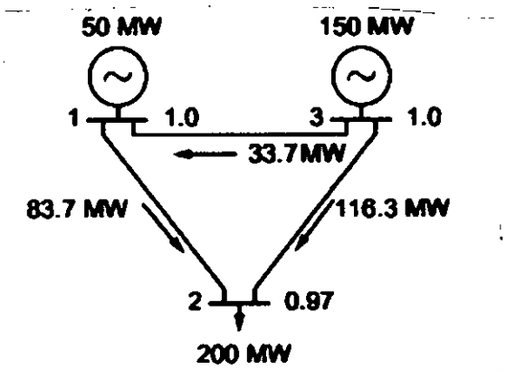

Fig for Q.4(b)

Line	Resistance (pu)	Reactance (pu)	P_f^{max} (MW)
1-2	0.001	0.01	100
2-3	0.001	0.015	110
1-3	0.001	0.012	50

(i) Find the percentage change in power flow in line 1-2 when the line 2-3 trips.

(ii) There is an overload in line 2-3. Formulate an OPF using DC load model to correct the overload. (You don't need to write inequality constraints)

(c) During security assessment what type of contingencies are considered? **(5)**

SECTION – B

There are **FOUR** questions in this section. Answer to **Question no. 5 is Compulsory.**

Answer any **TWO** questions from Questions 6-8.

5. (a) Discuss briefly the algorithm of state estimation for filtering error of digitally acquired and transmitted data in a large power system. **(6)** (CO2)

(b) In the small power system with two buses shown in Fig. for Q. 5(b), one wattemeter measures real power P_{12} (z_1) and two varmeters measure reactive power Q_{21} (z_2) and Q_1 (z_3). Here, state variables, $|V_1| = x_1, |V_2| = x_2, \delta_2 = x_3$. Formulate the equations to model the relationship between the measurements (z_1, z_2 & z_3) and the state variables. **(12)** (CO2)

Contd P/4

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

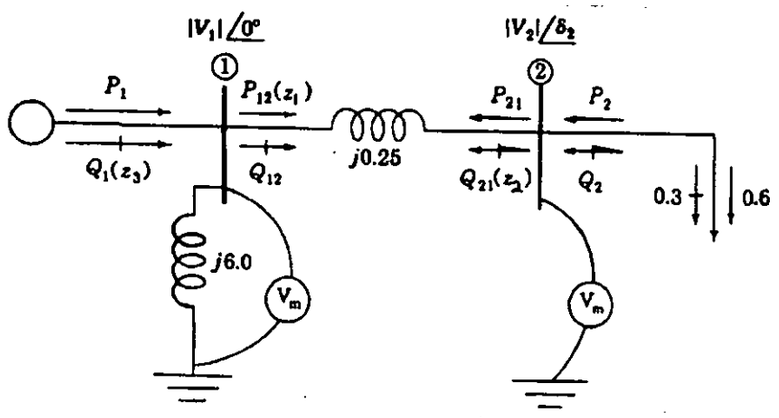

Fig. for Q. 5(b)

(c) Suppose, there are three generating units and two demands for a certain hour on a particular day in an electricity market. Each unit offers three blocks while each demand bids four blocks. The technical characteristics of the generating units are given in Table-1 for Q. 5(c). The offers by the generators and bids by the demands are given in the Table-2 for Q. 5(c). Calculate and compare the Social Welfare (SW) on that hour in the following cases: **(17)**

(i) No constraint/limit on the generating units. (CO5)

(ii) Considering the ramp up limit only, ignoring the minimum power limit.

Table-1 for Q. 5(c)

Unit data	Unit 01	Unit 02	Unit 03
Capacity (MW)	30	25	25
Minimum power output (MW)	5	8	10
Ramp up/down limit (MW/h)	5	10	10
Initial status (On/Off)	On	On	On
Initial power output (MW)	10	15	10

Table-2 for Q. 5(c)

	Offers by the generators									**Bids by the demands**							
	Unit 01			**Unit 02**			**Unit 03**			**Demand 01**				**Demand 02**			
Block	1	2	3	1	2	3	1	2	3	1	2	3	4	1	2	3	4
Power (MW)	5	12	13	8	8	9	10	10	5	8	5	5	3	7	4	4	3
Price (S/MWh)	1	3	3.5	4.5	5	6	8	9	10	20	15	7	4	18	16	11	3

Contd P/5

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6. (a) Using the block diagram of a typical power generation unit, explain briefly how the frequency and voltage of a generator can be controlled. **(14)**

   (b) Showing the detailed block diagrams of Master Station and Remote Station, discuss the working principles of SCADA. **(14)**

   (c) Write down the basic and essential steps to control a power system. **(7)**

7. (a) Write down the basic differences between spot market and forward market. **(10)**

   (b) Describe briefly the services offered by the power marketers in an electricity market. **(15)**

   (c) "State estimator works in association with other components in EMS"- explain the statement. **(10)**

8. (a) Why Unit Commitment is needed in power system operation? **(5)**

   (b) The system load of Fig. for Q. 8(b) is to be supplied by combinations of the four generating units of the following table: **(30)**

Combinations

Generator	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	x_{12}	x_{13}	x_{14}	x_{15}
1	1	1	1	1	0	0	1	0	1	1	0	1	0	0	0
2	1	1	1	0	1	1	0	0	1	0	1	0	1	0	0
3	1	1	0	1	1	0	0	1	0	1	1	0	0	1	0
4	1	0	1	1	1	1	1	1	0	0	0	0	0	0	1

The following information are given:

(i) Generator 1 is must-run unit.

(ii) Among Generators 2, 3 & 4, at least two units must be kept running.

(iii) Due to some constraints, only combination x_3 is allowed to run when load level is 1400 MW.

(iv) The start-up cost of each thermal generating unit is $3000 and the shut-down cost is $1500.

(v) Minimum production costs for all the combinations at all load levels of the cycle are given below:

Load Level	Combination	Production Cost ($)
P_D = 1100 MW	x_1	68,772
	x_2	68,772
	x_3	67,188
	x_4	72,090
P_D = 1400 MW	x_1	87,642
	x_2	89,034
	x_3	87,354
	x_4	93,296
P_D = 1800 MW	x_1	114,708
	x_2	118,776
	x_3	infeasible
	x_4	infeasible

Contd P/6

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

Using the backward dynamic program, find the optimal unit commitment schedule, that traces the least cost path, at various stages of the load cycle.

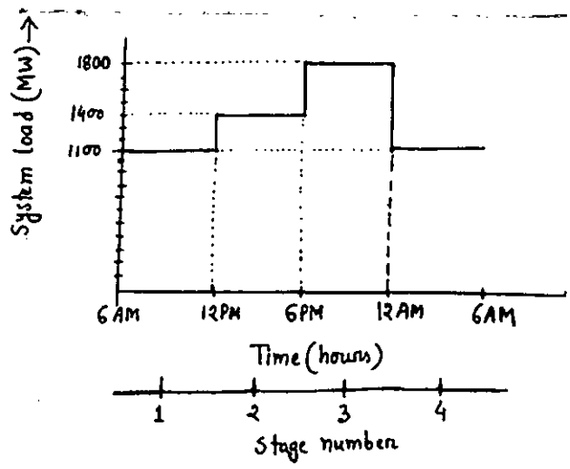

Fig. for Q. 8(b)

Course Outcomes of EEE 481: Power System Operation and Control	
COs	CO Statement
CO1	Apply mathematics and relevant engineering to model the components associated with power system operation and control.
CO2	Identify the emerging means for monitoring a power system and filtering error of digitally acquired and transmitted data in a power system.
CO3	Devise the techniques for balancing generation with demand in an economic and/or optimal way and for controlling frequency in normal or abnormal situation.
CO4	Analyse the impacts of contingencies on power system operation and identify the preventive or corrective means to reduce those considering various constraints.
CO5	Identify the barriers and requirements in implementing electricity market i.e. offering to the bulk consumers or distribution entities the flexibility in choice of electricity supplier and availing of competitive tariff.
CO6	Identify the requirements in transforming traditional power system into a smart grid.

L-4/T-1/EEE **Date: 04/05/2024**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B.Sc. Engineering Examinations 2022-2023

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

Full Marks: 210 Time: 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

The corresponding Couse Outcomes (COs) of each part of Question 1 and 5 are mentioned on the right most column. The COs of the course are mentioned at the end of the question paper.

SECTION – A

There are **FOUR** questions in this section. **Question No. 1 is compulsory**. Answer any **TWO** questions from remaining Questions.

1. (a) With necessary sketches describe different types of link used for HVDC power transmission. **(12)** (CO3)

   (b) Explain how low voltage and low power factor distribution of electric power increases system losses. **(8)** (CO5)

   (c) The self capacitance of each unit in a string of three suspension insulators is C. The shunt capacitance of the connecting metal work of each insulator to earth is 0.15 C while for line it is 0.1 C. Calculate - **(15)** (CO2)

   i) the voltage across each insulator as a percentage of the line voltage to earth and

   ii) string efficiency.

2. (a) For EHV transmission line in a country with heavy snow fall which one of the following line configurations should be chosen? Justify your answer explaining each point of view. **(12)**

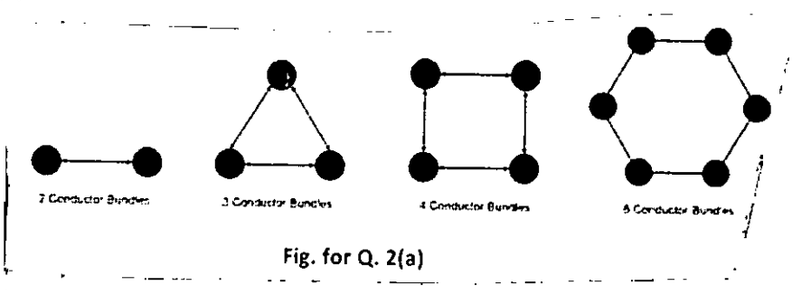

Fig. for Q. 2(a)

   (b) Derive the expression for inductance of single circuit three-phase lines with unsymmetrical spacing. **(12)**

Contd..... P/2

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

(c) A 3-phase single circuit bundled conductor line with three sub-conductors per phase has horizontal spacing with 6.1 m between the center lines of adjacent phases. The distance between the sub conductors of each phase is 30.5 cm and each sub-conductor has a diameter of 2.54 cm. find the inductance per phase per km. **(11)**

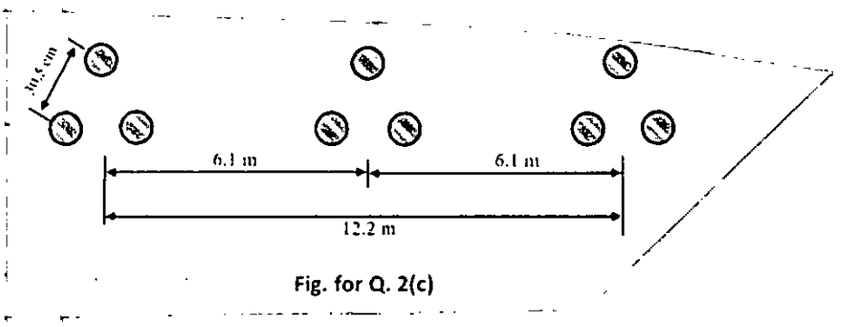

Fig. for Q. 2(c)

3. (a) Discuss the causes and nature of sub-conductor vibration of transmission line conductor. How can this vibration be controlled? **(12)**

(b) Show that a DC transmission link having two conductors can transmit the same amount of power that a 3-phase transmission line have three conductors can transmit. **(12)**

(c) Consider an existing three-phase high-voltage cable circuit made of three single-conductor insulated power cables. The loading of the circuit is thermally limited at the cable rms ampacity current I_L. Assume that the normal ac operating voltage is E_p. Now assume that the cable circuit is used for HVDC operation wherein one of the three existing cables is used either as a spare or as the grounded neutral conductor. Assume that factor $K\left(\equiv \frac{V_d}{2}/E_p\right)$ is 3 and determine: **(11)**

i) Maximum operating V_d in terms of voltage E_p

ii) Maximum power transmission capability ratio, that is, ratio of $P_{(dc)}$ to $P_{(ac)}$

iii) Ratio of total I^2R loses, that is, ratio of $P_{loss(dc)}$ to $P_{loss(ac)}$, that accompany maximum power flow. (Assume that the power factor for the ac operation is unity and that the skin effect is negligible.)

4. (a) Define the following characteristics of insulators used for OH lines: **(8)**

i) Section length, ii) Dry arc length, iii) leakage distance, and iv) Protected leakage distance.

(b) Describe different factors that affect the production of corona inn transmission lines. **(12)**

(c) Describe different types of connection scheme of power distribution system. What are their merits and demerits? **(15)**

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SECTION – B

There are **FOUR** questions in this section. **Question No. 5 is compulsory**. Answer any **TWO** questions from remaining Questions.

5. (a) i. An arrangement of 3-phase, 50 Hz-220 kV overhead transmission line having two strand bundle per phase is shown in Fig. for Q. 5(a). **(20)** (CO1)

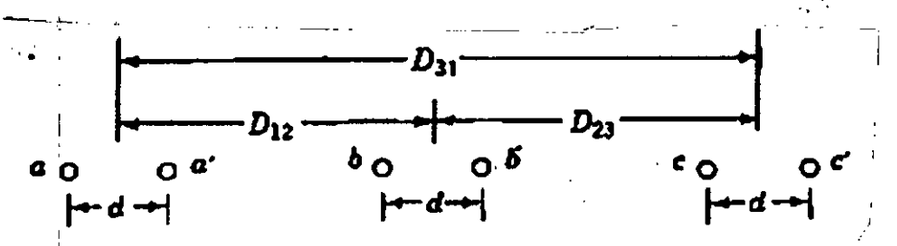

Fig. for Q 5(a)

Derive the expression of line to neutral capacitance for this arrangement (Assume the separation between two phases is much greater than that of between two strands in a phase and in each phase and charge is equally divided into two strands).

ii. If charging current per km length is to be not more than 0.8A, then determine the diameter of the conductor $[D_{12} = D_{23} = 8m, d = 0.45m]$

(b) Present a list of the major equipment of a step-up or a step-down sub-station. Describe the functions of each equipment along with mentioning the significant characteristics. **(15)** (CO4)

6. (a) Draw a sag diagram for a transmission line showing sags for various times and loading. Also define briefly all the labels mentioned in the diagram. **(12)**

(b) How does the effect of wind on sag can be modeled? Explain with necessary equation. **(5)**

(c) With mathematical explanation verify that though a ungrounded neutral system poses no problem under normal condition, system may face insulation breakdown or arcing during single line to ground fault. **(18)**

7. (a) Considering the effect of earth derive the expression of line to neutral capacitance for a 3-phase overhead transmission line with equilateral spacing. **(15)**

(b) Two towers of height 30 m and H m respectively support a transmission line conductor at water crossing. The horizontal distance between the towers is 500 m. The tension in the conductor is 1600 kg. Weight of the conductor is 1.5 kg/m. Bases of he towers can be considered to be at water level. If the lowest point of the conductor is to be maintained at least 25 m above water surface, then find the height H of the 2nd tower. **(15)**

(c) With proper explanation draw a comparison between overhead transmission line and insulated cable in perspective of capacitance and charging current. **(5)**

Contd..... P/4

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8. (a) A single core cable for use on 11 kV, 50 Hz, system has conductor diameter 0.906 cm and internal diameter of sheath is 2.18 cm. the permittivity of the dielectric used in the cable is 3.5. Find **(12)**

i. The maximum electrostatic stress in the cable

ii. Capacitance of the cable per km length

iii. Most economic conductor size that results in smallest value of maximum stress.

(b) Describe with necessary equations and figures how capacitance grading ensures uniform stress distribution in cables. **(15)**

(c) Draw the **Ring Main** bus bar arrangement in a sub-station and mention its disadvantages. **(8)**

Course Outcomes of EEE 485

COs	CO Statement
CO1	**Understand** the fundamentals of overhead and underground transmission line parameters, **calculate** transmission line parameter based on line design.
CO2	**Understand** and **analyze** the electrical and mechanical stresses on transmission line conductors and insulators, and **solve** basic design problems of transmission line.
CO3	**Understand** the basics of HVDC transmission systems, and **explain** its operation
CO4	**Understand** the topological design of substation, and substation grounding.
CO5	**Understand** the basics of distribution systems losses and **propose** loss reduction strategies.

L-4/T-1/EEE Date: ~~28/04/2024~~ 19/05/2024

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2022-2023

Sub: **CSE 451** (Computer Network)

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 **Q. No. 1** and any **TWO** from the rest.

1. (a) Why do we need UDP if this protocol has so many drawbacks? Describe two use cases where UDP is preferred over TCP. **(10)**

(b) In protocol RDT 3.0 (Reliable Data Transfer 3.0), the ACK packets flowing from the receiver to the sender do not have sequence numbers (although they do have an ACK field that contains the sequence number of the packet they are acknowledging). **Illustrate** how these ACK packets do not require sequence numbers? **(10)**

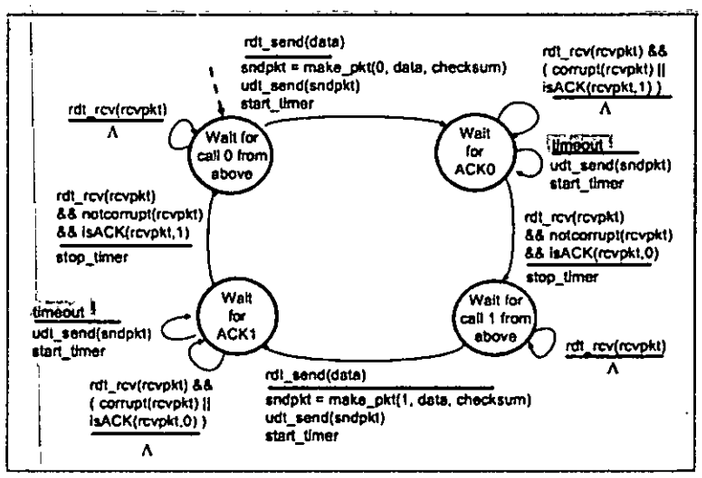

Figure 1(b): RDT 3.0 Sender Finite State Machine

(c) Give a selective repeat ARQ protocol setup with the following parameters: **(15)**

- Sequence numbers are utilized in a base-4 counting system: 0, 1, 2, 3.
- The sender's window size is set to 3.

Formulate and **explain** the potential wrap-around problem that could arise in this scenario due to the combination of the limited sequence number space and the specified window size.

2. (a) In distance-vector routing good news (decrease in a link metric) will propagate fast and bad news (increase in a link metric) will propagate slowly. In Figure 2(a), assume that a four-node internet is stable. Now consider the following scenario(s): **(8+12=20)**

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

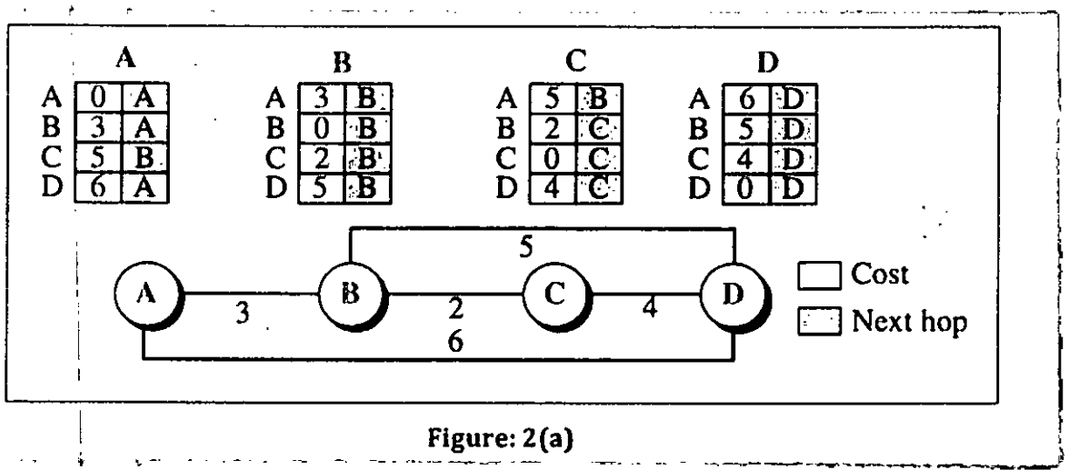

Figure: 2(a)

(i) The distance between nodes A and D, which is currently 6, is decreased to 1. Show how this good news is propagated and find the new distance vector for each node after stabilization.

(ii) The distance between nodes B and C, which is currently 2, is increased to infinity (link fails). Show how this bad news is propagated and find the new distance vector for each node after stabilization. Assume that the implementation uses a periodic timer to trigger updates to neighbors (no more updates are triggered when there is change). Also assume that if a node receives a higher cost from the same previous neighbor, it uses the new cost because the old advertisement is not valid anymore.

(b) Given a TCP connection with an initial congestion window of 4 MSS (Maximum Segment Size) operating under the AIMD (Additive Increase Multiplicative Decrease) algorithm for congestion control. **(7+8=15)**

- The additive increase in 1 MSS for each RTT (Round Trip Time) during which all packets are acknowledged without loss.
- The multiplicative decrease reduces the congestion window by 25% whenever packet loss is detected.
- After 3 RTTs, a packet loss is detected.

(i) Calculate the congestion window size just before and immediately after the packet loss.

(ii) Determine the size of the congestion window after an additional 2 RTTs of successful transmissions without any loss.

3. (a) Suppose that the five measured SampleRTT values are 106 ms, 120 ms, 140 ms, 90 ms, and 115 ms. Compute the EstimatedRTT after each of these SampleRTT values is obtained, using a value of $\alpha = 0.125$ and assuming that the value of EstimatedRTT was

Contd P/3

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Contd... Q. No. 3(a)

100 ms just before the first of these five samples were obtained. Compute also the DevRTT after each sample is obtained, assuming a value of $\beta = 0.25$ and assuming the value of DevRTT was 5 ms just before the first of these five samples was obtained. Last, compute the TCP TimeoutInterval after each of these samples is obtained. **(15)**

(b) In RDT protocols, why did we need to introduce sequence numbers? Why did we need to introduce timers? **(5+5=10)**

(c) What is Flow Control? How is this different from Congestion Control? How does TCP ensure Flow Control? Provide justifications. **(10)**

4. (a) Consider the following figure: **(20)**

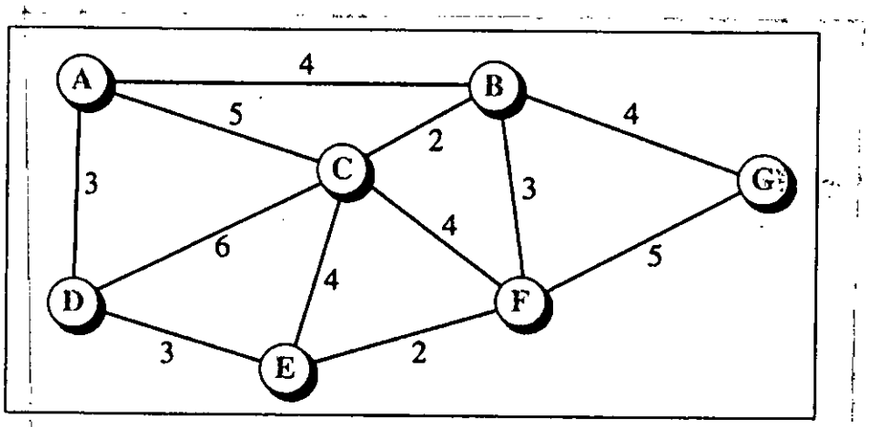

Figure 4(a)

Use Dijkstra's Link State Routing (LSR) algorithm to find the least-cost-path tree from node A. Also write the resultant forwarding table at node A.

(b) Assume a sender sends 6 packets: packets 0, 1, 2, 3, 4, and 5. The sender receives an ACK with ackNo = 3. What is the interpretation if the system is using Selective Repeat or Go-Back-N? **(15)**

SECTION – B

There are **FOUR** questions in this section. Answer **Q. No. 5** and any **TWO** from the rest.

5. (a) Suppose you walk into a room, connect to Ethernet, and want to download a Web page. **Design** and **explain** all the protocol steps that take place, starting from powering on your PC to getting the Web page. Assume there is nothing in our DNS or browser caches when you power on your PC. Explicitly indicate in your steps how you obtain the IP and MAC addresses of a gateway router. **(20)**

Contd P/4

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Contd... Q. No. 5

(b) Assume the generator G (=1001) is used in CRC. **Analyze** how this generator can detect any single bit error in data D. **(5)**

(c) Consider the following scenario(s) of ARP (Address Resolution Protocol) and determine the problem of each with necessary explanation. **(5+5=10)**

(i) There is no TTL (Time To Live) value in the ARP table entries.

(ii) Nodes are not continuously running the ARP program within themselves.

6. (a) Suppose, you (Hostname: *ckruet.edu*) are querying the IP-address for *eee.buet.edu*. However, BUET maintains an authoritative DNS server: *dns.buet.edu* for the hostnames ending with *buet.edu*. List all the DNS record(s) stored in (i) .edu TLD DNS server and (ii) *dns.buet.edu* DNS server that facilitate(s) your query. You need to mention the record(s) in this format (Name, Value, Type). Feel free to use any IP address(es) of your choice if need arises. **(10)**

(b) Given dataword (D)101001111 and the generator (G) 10111, show the generation of the CRC codeword at the sender site. **(15)**

(c) "In a P2P architecture, there is minimal (or no) reliance on dedicated server."— do you agree? Provide brief justification. **(10)**

7. (a) What is the main improvement CSMA brought over ALOHA variants (Plain ALOHA and Slotted ALOHA)? Could CSMA solve the problem entirely? What CSMA problem is addressed by CSMA/CD? With proper example scenario, describe. **(10)**

(b) Derive the maximum efficiency of slotted ALOHA protocol. **(15)**

(c) Consider an application that transmits data at a steady rate (for example, the sender generates an N-bit unit of data every k time units, where k is small and fixed). Also, when such an application starts, it will continue running for a relatively long period of time. Would a packet-switched network or a circuit-switched network be more appropriate for this application? Why? Briefly justify your answer. **(10)**

8. (a) "Third-party cookies compromise user privacy"— evaluate this statement with proper example(s). **(20)**

(b) Consider sending over HTTP/2 a Web page that consists of one video clip, and five images. Suppose that the video clip is transported as 2000 frames, and each image has three frames. **(7+8=15)**

(i) If all the video frames are sent first ***without interleaving***, calculate the number of frames to be transported until all five images are sent.

(ii) If frames are ***interleaved***, calculate the number of frames needed until all five images are sent.
