L-3/T-2/EEE **Date : 18/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **EEE 309** (Communication Theory)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

Answer in brief and to the point.

1. (a) Name and define the distortions caused by a communication channel to a signal. Comment on how they are mitigate in a practical communication system. **(4+6=10)**

(b) What is noise? Distinguish between noise and interference. **(5+5=10)**

Define signal to noise ratio (SNR) and mention its significance in analog communication system. What is the acceptable level of SNR for voice communication through a telephone channel?

(c)Write down the equation for thermal noise in an electrical circuit and from there, derive an expression for the maximum noise power transferred to a resistive termination. **(8+7=15)**

Calculate the maximum available thermal noise (in watt) that a resistive termination in a standard band-limited telephone channel (300 Hz – 3400 Hz) will produce at an ambient temperature of 17° C. Also, express it in dBm.

2. (a) Define telecommunication and describe the fundamental limitations of telecommunication in brief. **(8+4=12)**

Using a concise statement, mention, why is long-distance communication difficult to achieve using analog signal transmission?

(b) What do you understand by the terms, information content and system capacity (information rate) of a communication system? **(5+10=15)**

A discrete memoryless source consists of an alphabet set of four letters, s = {A, B, C, D}. For transmission, each letter is encoded into a sequence of two binary (on-off) pulses. The A is represented by 00, the B by 01, the C by 10, the D by 11. Each individual pulse interval is 5 ms.

(i) Calculate the average rate of transmission of information in bits/s, if the different letters are equally likely to occur,

(ii) Find the average rate of transmission of information in bits/s, when the probability of occurrence of each letter is respectively, $P_A = \frac{1}{5}, P_B = \frac{1}{4}, P_C = \frac{1}{4}, P_D = \frac{3}{10}$.

(c) Write down the Shannon's maximum capacity theorem and explain each term in it. Also, explain how SNR can be interchanged with the signal band width to achieve the same capacity as proposed by A. H. Reeves of Bell laboratory.

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3. (a) Define modulation and mention three purposes of modulation. **(5+8=13)**

Define modulation index, m_a, for AM and comment on its maximum value. Referring to the basic block diagram of an amplitude modulator, draw a single-tone modulating signal, the carrier wave and the AM wave for modulation index of $m_a = 1$ and $m_a = 1.5$.

(b) Suppose that an AM wave is represented by

$$s(t) = Ac[1 + 0.3\cos(2\pi f_1 t) + 0.4\cos(2\pi f_2 t)]\cos(2\pi f_c t); \quad \textbf{(3+6=9)}$$

where, the symbols have their usual meanings.

Calculate the overall modulation index, m_a. Also, calculate the power efficiency of the modulator.

(c) Why the radio broadcast stations transmit the total amplitude modulated wave (DSB – TC) in AM radio transmission compared to other power and bandwidth efficient methods? **(4+9=13)**

With suitable sketch(es) briefly describe the operation of an envelope detector for AM. Also, comment on the choice of RC values of such a detector.

4. (a) Define FM and comment on its relative merits and demerits over AM. **(4+8=12)**

Show, with suitable equations and diagrams, the relationship between PM and FM.

(b) Find the FM and PM waves for the modulating signal, m(t), as shown in Fig. for Q. No. 4 (b). **(8)**

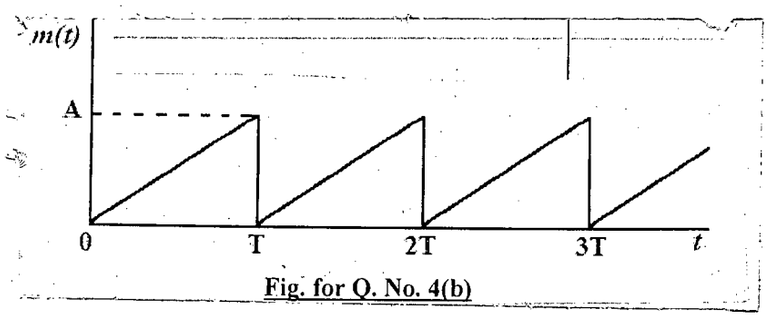

Fig. for Q. No. 4(b)

(c) Consider an FM system with a single tone message with amplitude $A_m = 2$ volts and frequency $f_m = 10$ kHz. The carrier has an amplitude $A_c = 4$ volts and frequency $f_c = 8$ MHz. Using the Bessel function plot shown in Fig. for Q. No. 4 (c),

(i) Determine the modulation index β for which, the component in FM signal with frequency $(f_c + f_m)$, has 25% of the total transmitted power. **(4)**

(ii) Calculate the bandwidth using Carson's rule. **(3)**

(iii) Draw the FM amplitude spectrum. **(4)**

(iv) how many significant sidebands are contained within the bandwidth calculated in part (ii)? **(2)**

(v) Now, using the FM amplitude spectrum, calculate the bandwidth using the 1% rule. **(2)**

Contd P/3

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SECTION-B

There are **FOUR** questions in this section. Answer any **THREE** questions.
Answer in brief and to the point. Make reasonable assumptions on any missing information.

5. (a) With necessary diagrams, explain a technique for achieving non-uniform quantization using a uniform quantizer. **(7)**

(b) A 4-bit PCM system uses non-uniform quantization with A-law (A = 100) compression. Sampling rate of the system is 10 kHz and the first sample is taken at $t = 0.2$ ms. The quantizer is truncation based symmetric mid-rise type. Message signal of the PCM system is $m(t) = m_1(t)m_2(t)$, where $m_1(t) = 5\cos(2000\pi t)$ and $m_2(t) = 4\cos(10000\pi t)$. Signal range is [-20, 20] and quantizer range is [-16, 16]. Assume that the maximum value of the compressor output is same as the message peak. Calculate the- **(18)**

(i) decision thresholds and the quantization levels of the quantizer.
(ii) quantized values and the quantization errors for the first for samples.
(iii) bit rate of the system.

(c) Now assume that for the system in question 5(b), a 4-bit uniform quantizer is used instead of the non-uniform quantizer (other features are same). **(10)**

(i) Calculate the bit rate and the SQNR of the system.
(ii) If sampling frequency is doubled, calculate the new bit rate and the SQNR of the system.
(iii) For the new sampling frequency as in part (ii), draw the amplitude spectrum of the sampled signal.

6. (a) Consider a system with 500 user pairs (transmitter-receiver). Design and draw the transmitter side of a T-carrier based communication system by accommodating all the users. **(10)**

(b) Consider a TDMA based communication system with 8 source-destination pairs. Each source has a signal bandwidth of 8 kHz. Source signals are sampled at a rate of 150% above the Nyquist frequency and encoded using sequences of 7 bits length. If the interleaved unit of a TDMA frame is one sample and 2 synchronizing bits are added to each TDMA frame, calculate the - **(15)**

(i) number of bits in each frame, (ii) frame rate, (ii) data rate of each source, and (iv) data rate of the link.

(c) Assume that the carrier of a FH-CDMA system hops among four frequencies given by $(f_c + 8n)$ kHz, where $f_c = 10$ kHz and n = 0, 1, 2, 3. draw the block diagram of the transmitter including the frequency table. If the PN-code for the system is [0 1 1 0 1 1 0 0 1 1 1 0], draw a diagram showing the hoping of carrier frequency with hop periods. **(10)**

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7. (a) Draw the block diagram of QPSK receiver. If the QPSK signal by $s(t) = a_1(t)\cos(2\pi f_c t) - a_2(t)\sin(2\pi f_c t)$, (i) determine the phases for various bit sequences and draw the constellation diagram for the system, (ii) Write the time-domain expression of signals at each of the receiver, and (iii) determine the decision criteria for detecting the I – channel and Q-channel bits. Here $a_1(t)$ and $a_2(t)$ are the NRZ-L coded waveform for the bits transmitted over I-channel and Q-channel respectively. **(12)**

(b) A bit sequence [1 0 1 1 0 1 0 0] is to be transmitted using DPSK modulation. Assume '1' means transition and the reference bit (encoded) is '1'. **(13)**

(i) Determine the DPSK encoded bit sequence.

(ii) Draw the block diagram of the DPSK transmitter and the receiver with the appropriate logic gate at the transmitter and decision criteria at the receiver.

(iii) If for some disturbances in the channel, polarity of the received signal after the sampler is found as [+ - - + + - + -], determine the number of bits erroneously detected.

(c) Consider a 3-users DS-CDMA system with PN sequences $[-1+1+1-1]$, $[+1-1-1+1]$ and $[-1-1-1-1]$ respectively. If the signal in the channel is $[-3+2-1-2+1+3-3+1]$ and the channel is free from any disturbance, **(10)**

(i) draw the baseband signal after de-spreading at receiver 2.

(ii) draw the baseband signal after spreading at transmitter 2.

(iii) determine the detected bit sequence at receiver 3.

8. (a) Prove that the improvement in SQNR in a DPCM system compared to a PCM system using the same number of quantization levels is proportional to $(A_m/E_m)^2$, where $[-A_m, + A_m]$ and $[-E_m, + E_m]$ are the ranges of the message signal and the error signal respectively. **(8)**

(b) Derive the time-domain and frequency-domain expressions of natural PAM signal. With necessary diagrams, identify and explain three different parameters affecting the bandwidth of PAM signals. **(15)**

(c) Compare and contrast the line coding schemes as specified below. **(12)**

(i) NRZ-S and Manchester with respect to self-clocking feature.

(ii) Unipolar RZ and Bipolar RZ with respect to error detection capability.

(iii) Unipolar NRZ and Polar NRZ with respect to noise immunity.

(iv) Unipolar NRZ and Manchester with respect to transmission bandwith.

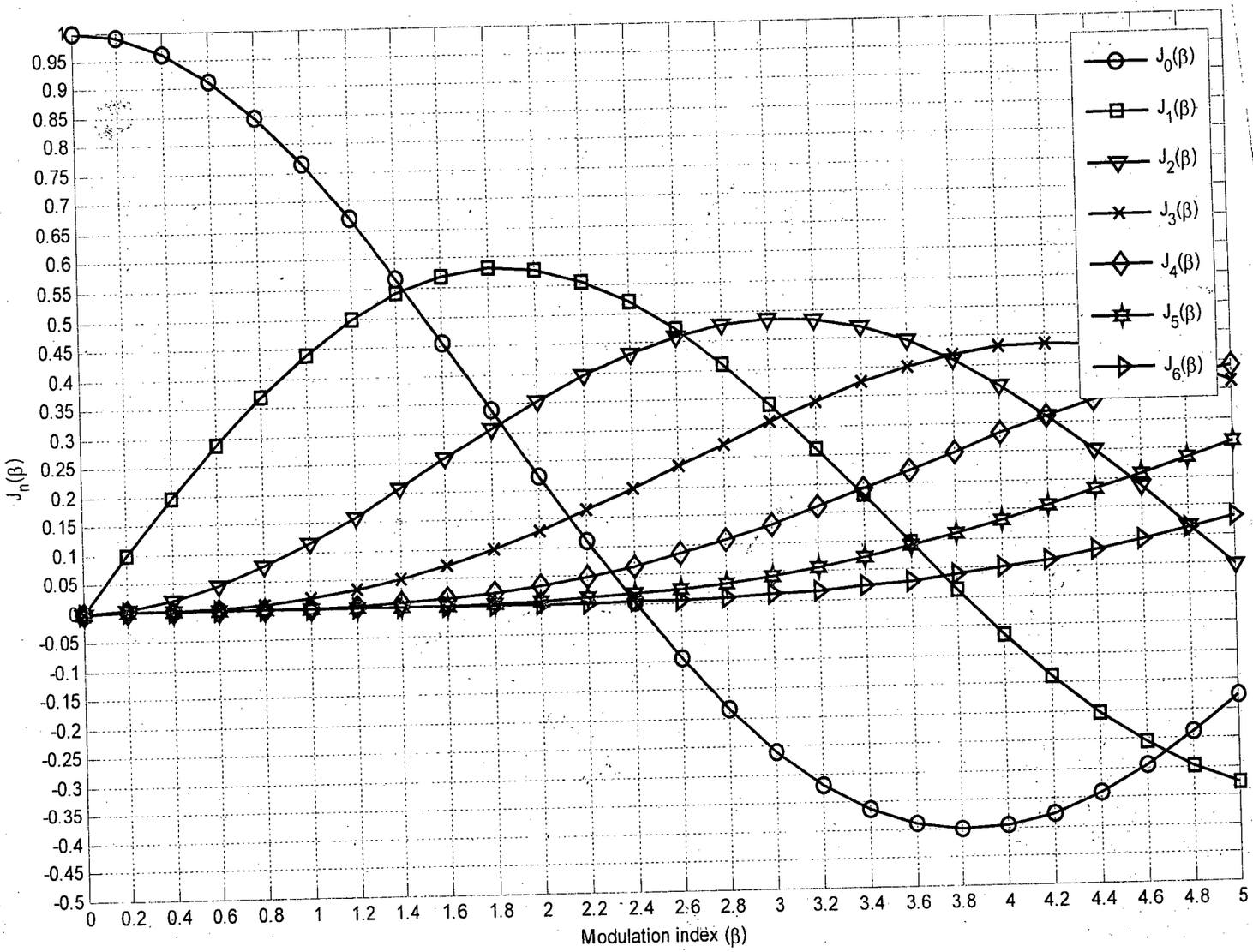

Fig. for Q. No. 4(c)

L-3/T-2/EEE **Date : 24/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **EEE 315** (Microprocessor and Interfacing)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) Write an assembly language program to find the median of a byte type array. End of the array is marked with a '$' character. **(15)**

At first, sort the array in either ascending or descending order. The middle value of the sorted array is defined as the median. If the array contains even number of components, median will be the average of the two middle values.

(b) A memory location has the physical address 0F132h. Calculate the corresponding offset addresses of this memory location for the following three segments: (i) 0DA7h, (ii) FFE0h and (iii) F000h. **(10)**

(c) Explain how the direction flag controls string operations in an 8086 assembly program.

Use REPE and CMPSB commands in an assembly program to determine whether two strings are identical. Both strings have a length of 20 characters. **(4+6=10)**

2. (a) Execute the following code snippet in single step. Find the content of AX register and the status flags (CF, OF, ZF, PF, SF) after each individual step. Initial content of AX is FC80h. **(10)**

```
NEG AL
IMUL AH
RCR AL,1
INC AX
ADD AL, 0FEh
```

(b) Explain what happens when an assembly program enters a LOOP command with CX = 0. How should a careful programmer prevent this problem? **(10)**

(c) Write an assembly language program that converts any 4-digit decimal number into a packed Binary Coded Decimal (BCD) form and stores the BCD number in AX register. Packed BCD means that each byte contains two BCD digits, one digit in the upper nibble and the other digit in the lower nibble. For example, if the decimal number is 1355, its packed BCD output in AX will be 1355h. **(15)**

3. (a) Determine the addressing mode of each operand in the following instructions. **(10)**

```
MOV BX, 5
MOV DI, 5
LEA SI, A; A is an array, declared later in the code
MOV BYTE PTR [SI], 3
MOV CL, [BX+A]
MOV CH, 2[BX+DI+A]
```

Contd P/2

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Contd... Q. No. 3

(b) If you write a PUSH command within a procedure but forget to POP it, explain how it will affect your program. **(4+6=10)**

Write a near type procedure in assembly language that calculates the square root of a given number. A floor operation is assumed so that your program returns the greatest integer less than or equal to the actual value.

Sample Input	Sample Output
16	4
13	3
9	3

(c) Solution of a quadratic equation ($ax^2 + bx + c = 0$) is given by the following formula. **(15)**

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

A, B and C are three word type variables that contain the coefficients of a quadratic equation. Now write an assembly language program that calculates the solutions of that equation using this formula. A floor operation is assumed.

4. (a) Suppose you have to install eight $2k \times 8$ RAMs in your 8086 based microcomputer system. Two slots are available, each with a memory space of 8 kB. The first slot ranges from 18000h to 19FFFh, while the second slot ranges from 1C000h to 1DFFFh. Your system includes even-odd memory banking. **(25)**

Design an address decoder for this system using a 3-to-8 demultiplexer. Draw a block diagram of the decoder and memory system.

(b) Explain how even-odd memory banking helps to accomplish word-type operation in an 8086 processor. **(10)**

SECTION-B

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

5. The data outputs of an 8-bit analog-to-digital (A/D) converter are connected to PORTA of an 8255A PPI (base address 28H). The end of conversion of a signal from the A/D converter produces an interrupt of type 47 and is connected to one of the IR inputs of an 8259A PIC (base address 35H). Upon the occurrence of the interrupt, the output of the converter will be read by the system. If the MSB of the output data is a 0, indicating that the value is in the range, add the byte to a running total kept in a word type variable 'SUM'. If the MSB of the data is 1, indicating that the value is out of range, ignore this data. After 20 samples have been totaled, divide by 20 to get the average and store this to another word type variable 'RESULT'

(a) Draw the connection diagram of the system without address decoding. **(10)**

(b) Write an assembly language code for your design with proper initializations. **(10)**

Contd P/3

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6. (a) Suppose for an experiment you have to take 100 samples in a interval of 20 ms. You have only an 8254 timer IC (base address 38H) available to design the timer circuitry needed to keep track the sample number and interval time. The input clock frequency for 8254 is 4.9152 MHz. **(5+20)**

   (i) Draw the schematic of your design

   (ii) Write an assembly language code for your design.

   (b) Briefly describe the read cycle of 8086 microcomputer. **(10)**

7. Design a display board containing four common anode seven segment displays which are to be operated using multiplexing technique. You have to use PORTA of 8255A PPI (base address 58H) for multiplexing. Also connect two switches named 'SW1' and 'SW2' to the PORTB of the 8255A PPI. Both of the switches are active high type switch.

   (a) Draw the schematic of your design. **(8)**

   (b) Write an assembly language code for the following requirements in your design, **(27)**

   (i) If 'SW1' is pressed then the four seven segment will display 8086.

   (ii) If 'SW2' is pressed then the seven segment will display 8255.

   (iii) If both or none of the switches are pressed the seven segments will remain off.

   (iv) Use polling method for detecting a switch press.

8. Two microcomputers are connected to each other through two 8251A USARTs. The base address for USART1 is 60H and USART2 is 70H. Input clock frequency for both USARTs is 614.4kHz.

   (a) Draw the schematic of the system. **(5)**

   (b) A serial data of 8 bits has to be sent from one computer to another. Use the baud rate of 9600 Bd, one stop bit, odd parity, disabled error reset, disabled hunt mode and no break character to send this data through USART1. Construct the mode and command words that must be sent for USART1. **(10)**

   (c) Write the instructions for worst case initialization of this USART1 and a procedure to send the data in polling method. **(12)**

   (d) Write an assembly language procedure for USART2 to receive a 8 character string from USART1 using polling method. **(8)**

Contd..... P/4

8255A Mode Set Control Word

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

8251 Mode Instruction (Asynchronous Mode)

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

8251 Command Word

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

8251 Status Word

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

8254 Control Word

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

8259 PIC Control Words

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

L-3/T-2/EEE **Date : 28/02/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **IPE 493** (Industrial Management)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. (a) The following table contains information on the cost to run three jobs on four available machines. Determine an assignment plan that will minimize costs and compute the total minimum costs. **(12)**

		Machine			
		A	**B**	**C**	**D**
	1	12	16	14	10
Job	**2**	9	8	13	7
	3	15	12	9	11

(b) A group of six jobs is to be processed through a two-machine flow shop. The first operation involves cleaning and the second involves welding. Determine a sequence that will minimize the total completion time for this group of jobs. Also construct a Gantt chart to reveal flow time and idle time information. **(15)**

	Processing Time (Hours)	
Jobs	**Work Center 1**	**Work Center 2**
A	5	5
B	4	3
C	8	9
D	2	7
E	6	8
F	12	15

(c) Write down Taylor's Scientific Management Principles. **(8)**

2. (a) Explain the types of problems and decisions. **(12)**

(b) Using the given data in following Table – 1, prepare a forecast for period 6 using each of these approaches: **(13)**

(i) The appropriate naive approach.

(ii) The three-period moving average.

(iii) A weighted average using weights of 0.50 (most recent), 0.30, and 0.20.

(iv) Exponential smoothing with a smoothing constant of 0.40.

Contd P/2

IPE 493/EEE

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

Table-1

Period	Number of Complaints
1	60
2	65
3	55
4	58
5	64

(c) A toy manufacturer uses approximately 32,000 silicon chips annually. The chips are used at a steady rate during the 240 days a year that the plant operates. Annual holding cost is $3 per chip, and ordering cost is $120. Determine the optimal order quantity and the number of work days in an order cycle. **(10)**

3. (a) Contrast mechanistic and organic organizations. **(10)**

(b) Given the following production schedule in units and the production standards for labor and machine time for this product, determine the labor and machine capacity requirements for each week. Then compute the percentage utilization of labor and machines in each week if labor capacity is 200 hours per week and machine capacity is 250 hours per week. **(10)**

Production Schedule:

Week	1	2	3	4
Quantity	200	300	100	150

Standard Time:

Labor	0.5 hour/unit
Machine	1.0 hour/unit

(c) The Dine Corporation is both a producer and a user of brass couplings. The firm operates 220 days a year and uses the couplings at a steady rate of 50 per day. Couplings can be produced at a rate of 200 per day. Annual storage cost is $2 per coupling, and machine setup cost is $70 per run. **(10)**

(i) Determine the economic run quantity.

(ii) Approximately how many runs per year will there be?

(iii) Compute the maximum inventory level.

(iv) Determine the length of the pure consumption portion of the cycle.

(d) What are the requirements for effective inventory management? **(5)**

4. (a) Describe the elements of a good forecast. What are some of the consequences of poor forecasts? Explain. **(12)**

(b) Explain the contingency factors that affect organizational design. **(9)**

(c) What guidelines should managers practice for making effective decision in today's world? Explain. **(14)**

Contd P/3

SECTION-B

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

5. (a) Advanced Modular Technology (AMT) typically exhibits net annual revenues that increase over 5 years as expressed by the following formula. **(20)**

Net revenues in the year k = \$20,000+\$10,000 × (k-1)

The capital investment at the beginning of the project was \$100,000. AMT obtains a salvage value of \$10,000 at the end of the project by selling some of its unused machineries to a third party.

(i) Draw the cash flow diagram.

(ii) Compute the IRR.

(iii) Compute the discounted payback period.

(iv) Evaluate this AMT project if the MARR is 20% per year and the maximum allowable discounted payback period is 3 years.

(b) What do you understand by contingency theories of leadership? Briefly explain Fiedler contingency model and its limitations. **(15)**

6. (a) What is marketing? What are the scopes of marketing? Give at least one example in each of the scope. **(15)**

(b) How do you describe consumer market, business market and global market? What are the popular marketing concepts? Provide an example for each of the case. **(20)**

7. (a) What do you understand by "Total Quality Management"? How does it help Japan to achieve high quality products over USA? **(10)**

(b) Explain the universality of management concept. Does it still hold true in today's world? Why or why not? **(10)**

(c) How do goal-setting theory and three-needs theory explain employee motivation? **(15)**

8. (a) Due to erratic sales of its sole product— a high-capacity battery for laptop computers—PEM, Inc., has been experiencing difficulty for some time. The company's contribution format income statement for the most recent month is given below: **(25)**

Sales (19,500 units × \$30 per unit).....	\$585,000
Variable expenses.....	409,500
Contribution margin.....	175,500
Fixed expenses.....	180,000
Net operating loss.....	\$(4,500)

Contd P/4

IPE 493/EEE

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

(i) Compute the company's CM ratio and its break-even point in both units and dollars.

(ii) The president believes that a $16,000 increase in the monthly advertising budget, combined with an intensified effort by the sales staff, will result in an $80,000 increase in monthly sales. If the president is right, what will be the effect on the company's monthly net operating income or loss?

(iii) Refer to the original data. The sales manager is convinced that a 10% reduction in the selling price, combined with an increase of $60,000 in the monthly advertising budget, will cause unit sales to double. What will the new contribution format income statement look like if these changes are adopted?

(b) Suppose that a father deposits an amount of $10,000 in a savings account on the day his son is born. If the father wants his son to get $50,000 on his 18th birthday, what should be the nominal interest rate compounded half-yearly? **(10)**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **EEE 311** (Digital Signal Processing I)

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

1. Two LTI system are connected in parallel as shown in figure below. The input-output relationships of the DT systems are also given. For an input of $x(n) = (-1)^n\,[u(n) - u(n-2)]$,

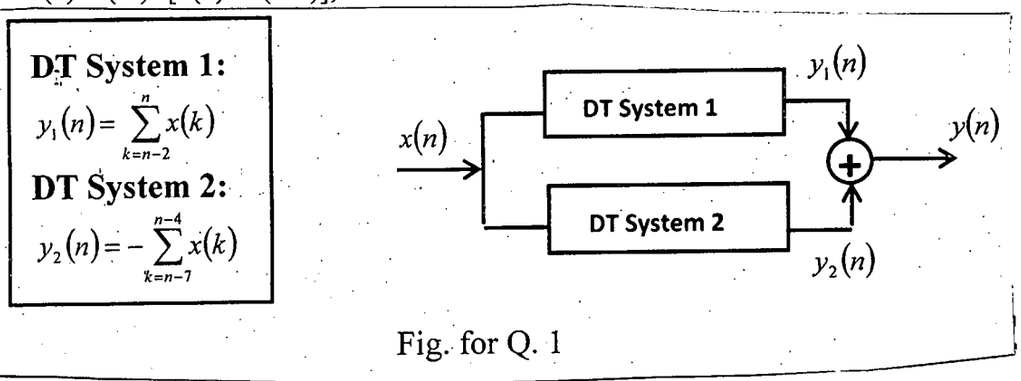

Fig. for Q. 1

(a) Determine and plot the impulse responses $h_1(n)$ and $h_2(n)$ of the DT systems 1 and 2, respectively. Also, determine whether the DT systems 1 and 2 are stable and causal. **(10)**

(b) Determine and plot the impulse response of the overall system. **(5)**

(c) Determine the output $y(n)$ of the overall system by convolution summation. **(10)**

(d) Find the output $y(n)$ using z-transform. **(10)**

2. (a) Define poles and zeros of a system and write their significances. Show that a causal LTI system will be stable provided all its pole lie inside the unit circle. **(10)**

(b) Describe Schür-Cohn stability test. Using this test determine the stability of a system with $h(n) = \left[\frac{1}{4}(-1)^n + \frac{3}{4} + \frac{1}{2}n\right]u(n)$. **(15)**

(c) Determine the unit step response of a system governed by $y(n) = 0.9y(n-1) + 0.81y(n-2) + x(n)$ under the initial condition of $y(-2) = y(-1) = 0$. **(10)**

3. (a) Define correlation and its different forms. Show that autocorrelation at zero lag has the highest value. With examples, describe the use of autocorrelation. **(15)**

(b) Find correlation between $\{\underset{\uparrow}{1}\ 2\ 3\ 4\}$ and $\{\underset{\uparrow}{4}\ 3\ 2\ 1\}$. **(10)**

(c) An analog signal $x_a(t) = \sin 480\pi t + 3\sin 720\pi t$ is sampled at 600Hz. Determine **(10)**

(i) Nyquist sampling rate and folding frequency

(ii) The frequencies in the resulting DT signal $x(n)$ and

(iii) The reconstructed signal if $x(n)$ is passed through an ideal DAC.

Contd P/2

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4. (a) For the following system, determine its impulse response $h(n)$. Consider $h(n)$ is the equivalent of two series-connected systems $h_1(n)$ and $h_2(n)$. If $h_1(n)=\delta(n)+\delta(n-1)$, find $h_2(n)$. **(15)**

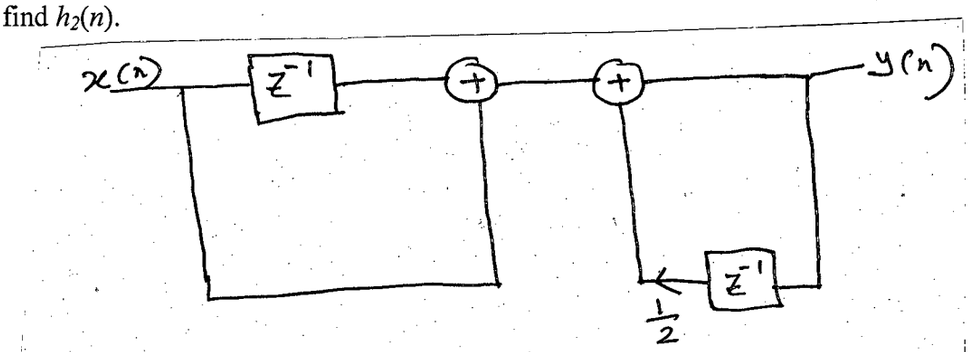

Fig. for Q. 4(a)

(b) Derive the expression of DTFS. Differentiate DTFS from CTFS. Determine the Fourier coefficients of the signal $x(n)=\cos\frac{2\pi}{3}n+\sin\frac{2\pi}{5}n$. **(10)**

(c) Determine and sketch the magnitude and phase response of a system governed by $4y(n)=x(n)-2x(n-1)+x(n-2)$. **(10)**

SECTION-B

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

5. (a) Given that $\tilde{x}[n]=\sum_{r=-\infty}^{r=\infty}x[n-rN]$. Discrete Fourier series coefficients corresponding to $\tilde{x}[n]$ is $\tilde{X}[k]$ and discrete Fourier transform of $x[n]$ is denoted as $X(e^{j\omega})$. Show that $\tilde{X}[k]$ can be expressed as a periodically sampled version of $X(e^{j\omega})$ between $\omega=0$ and $\omega=2\pi$. **(10)**

(b) Let $x[n]=0$, $n<0, n>7$ be a real eight-point sequence and let $X[k]$ be its eight-point DFT. Let $w[n]=0$, $n<0, n>3$ be a four-point sequence and let $W[k]$ be its four-point DFT. If $W[k]=X[k]+X[k+4]$, express $w[n]$ in terms of $x[n]$. **(10)**

(c) Two sequences $x_1[n]$ and $x_2[n]$ are given as follows, $x_1[n]=\{\underset{\uparrow}{-1}\ 2\ 1\}$, $x_2[n]=\{\underset{\uparrow}{2}\ 0\ -1\}$ **(15)**

(i) Find $X_1(k)$ and $X_2(k)$, the 3 point DFTs of $x_1[n]$ and $x_2[n]$, respectively.

(ii) If $v[n]$ is three point circular convolution between $x_1[n]$ and $x_2[n]$, calculate $v[n]$ from $X_1(k)$ and $X_2(k)$ using an inverse DFT.

Contd P/3

EEE 311

6. (a) A causal FIR system has the impulse response, **(10)**

$$h[n] = \{2 \underset{\uparrow}{} -4\ 8\ 8\ -4\ 2\}$$

(i) Mention the type of filter and its coefficients.

(ii) Draw the signal flow graph for this filter using three multipliers (maximum).

(b) Fig Q.6(b) shows that the signal flow graph for a causal discrete-time LTI system. Branches without gains explicitly indicated have a gain of unity. **(10)**

(i) Determine the difference equation relating $x[n]$ and $y[n]$.

(ii) Determine $h[1]$, the impulse response at n = 1.

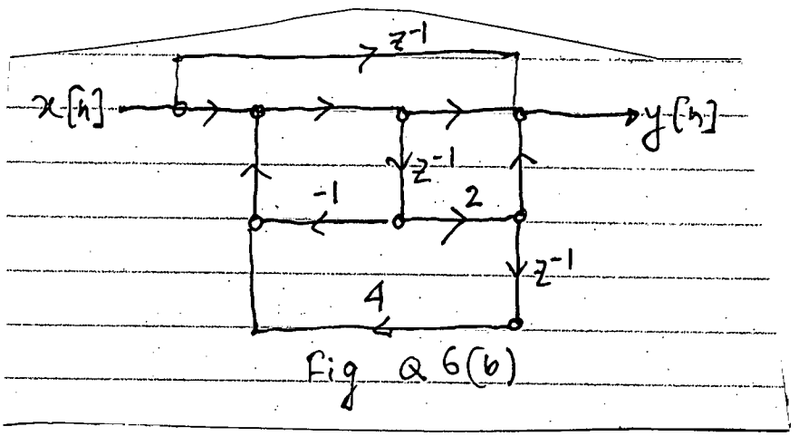

Fig Q 6(b)

(c) Find H(z) for the signal flow graph of a causal LTI system shown in Fig Q.6(c) (i). **(15)**

Carefully observe the signal flow graph shown in Fig Q.6(c) (ii). Does the system corresponding to Fig Q.6(c) (ii) represent the same input-output relationship as the system corresponding to Fig Q.6(c) (i)? Justify [You do not need to show the H(z) for the second system]. All branches of the signal flow graphs in this problem have unity gain unless specifically indicated otherwise.

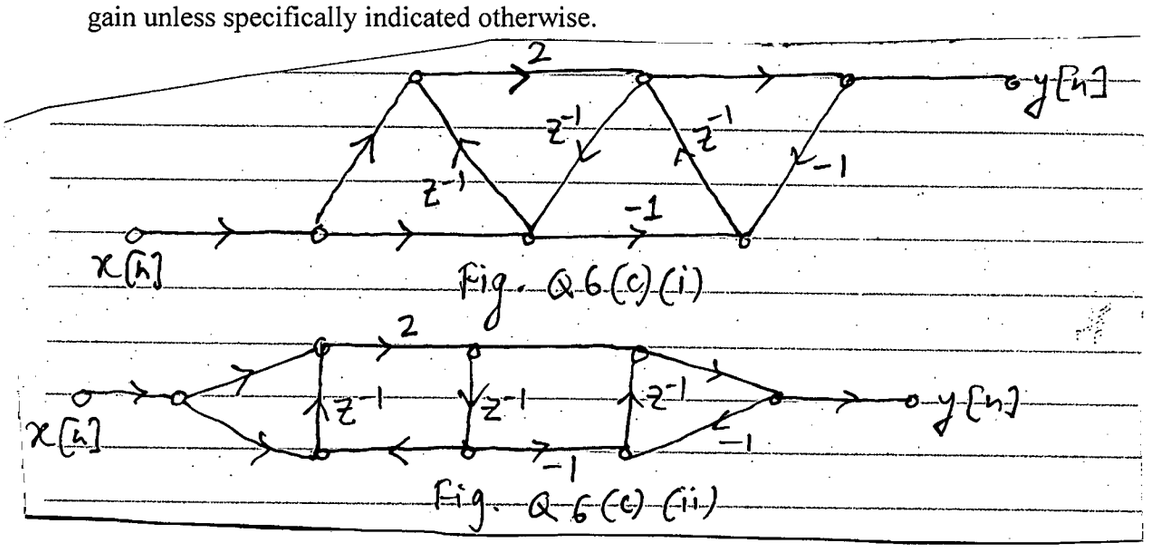

Fig. Q.6.(c).(i)

Fig. Q.6.(c).(ii)

7. (a) What are the two main problems of implementing an ideal FIR LPF? Mention how to overcome the problems? **(8)**

(b) What is the problem of using rectangular window? Explain logically why the use of Hamming window can reduce the problem? **(7)**

Contd P/4

EEE 311

Contd... Q. No. 7

(c) Use the Kaiser window method to design a real-valued type II FIR filter with generalized linear phase that meets the following specifications: **(20)**

$$\begin{aligned} 0.9 < H\left(e^{j\omega}\right) < 1.1, \quad & 0 \le |\omega| \le 0.2\pi, \\ -0.06 < H\left(e^{j\omega}\right) < 0.06, \quad & 0.3\pi \le |\omega| \le 0.475\pi, \\ 1.9 < H\left(e^{j\omega}\right) < 2.1, \quad & 0.525\pi \le |\omega| \le \pi \end{aligned}$$

Find Kaiser window function and impulse response of the filter.

8. (a) In the impulse-invariance method of discrete-time IIR filter design , what is meant by the term "impulse invariance"? What is the major limitation of this method? Mention a simple way to overcome the limitation. **(10)**

(b) Consider designing a discrete-time filter with system function H(z) from a continuous-time filter with rational system function $H_c(s)$ by the transformation

$$H(z) = H_c(s)\Big|_{s=\left(\frac{1-z^{-2}}{1+z^{-2}}\right)}$$

(i) Find the relationship between ω and Ω. **(25)**

(ii) Show that if $H_c(s)$ is a rational function with all its poles inside the left-half s-plane, then H(z) will be a rational function with all its poles inside the unit circle of the z-plane.

(iii) Find H(z) using the relationship obtained in (i) and considering a continuous-time Butterworth filter. The discrete-time filter is expected to meet the following specifications:

$$\begin{aligned} 0.9 \le \left|H\left(e^{j\omega}\right)\right| \le 1, \quad & 0 \le |\omega| \le 0.2\pi \\ \left|H\left(e^{j\omega}\right)\right| \le 0.2, \quad & 0.32\pi \le |\omega| \le \pi \end{aligned}$$

L-3/T-2/EEE **Date : 12/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

All the symbols and notations used in this section bear their usual meanings.

1. (a) For nanoscale MOS devices, management of threshold voltage is a huge challenge. Use mathematical models to relate the effect of various parameters on the threshold voltage. Hence draw the variation of threshold voltage as a function of substrate bias for *n*-channel devices with uniform channel doping (no channel implantion) and with non- uniform channel doping resulting from channel implantion. **(12)**

(b) For the common-gate configuration of a single stage MOSFET amplifier (without load), derive the expression of voltage gain. Modify this expression if a resistive load R_L is connected to the output terminal. **(10)**

(c) Derive the complete small-signal model for an NMOS transistor with I_D = 100 μA, V_{SB} = 1 V, V_{DS} = 2 V. Device parameters are φ_f = 0.3 V, W = 10 μm, L = 1μm, γ = 0.5 $V^{1/2}$, k' = 200 μA/V^2, λ = 0.02 V^{-1}, t_{ox} = 100 Å, ψ_0 = 0.6 V, C_{sb0} = C_{db0} = 10 fF. Overlap capacitance from gate to source and gate to drain is 1 fF. Assume C_{gb} = 5fF. **(13)**

2. (a) What are CC-CE and CC-CC Darlington configurations? Draw the small signal equivalent circuit of a Darlington pair amplifier and derive the combined gain β'. **(10)**

(b) What are the advantages of a cascode configuration? Identify the circuit given below in the Fig. for .Q. No: 2(b). Draw its small signal equivalent circuit, hence determine the transconductance and output resistance of this circuit. **(10)**

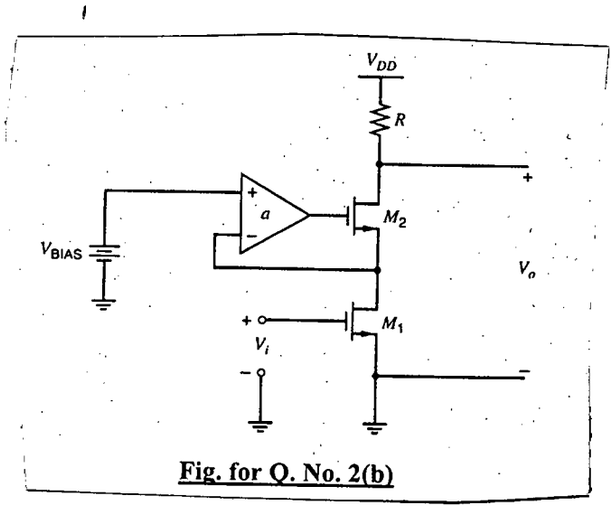

Fig. for Q. No. 2(b)

Contd P/2

EEE 351

Contd... Q. No. 2

(c) Two identical NMOS transistors are used as constant current sources in a system shown in Fig. for .Q. No. 2(c). However, due to internal circuitry of the system, V_X is higher than V_Y by ΔV. For this circuit - **(15)**

(i) Calculate the resulting difference between I_{D1} and I_{D2} if $\lambda \neq 0$.

(ii) Add cascode devices to M_1 and M_2 and repeat part (*i*).

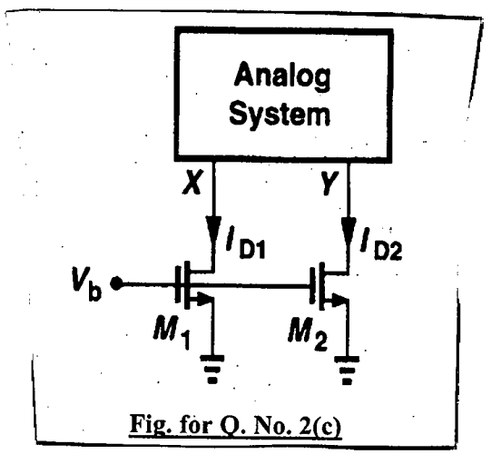

Fig. for Q. No. 2(c)

3. (a) Compare three common types of MOSFET switches referring to the value of their 'channel resistances'. Assume a 0-5V clock has to pass through a pass transistor/transmission gate. Draw the output voltage levels of the pass transistor/transmission gate separately for each switch. **(10)**

(b) Show the effect of junction capacitance nonlinearity in a *Switched-Capacitor Integrator*. Hence design a parasitic-insensitive *Switched-Capacitor Integrator*. **(12)**

(c) In the differential circuit shown in Fig. for .Q. No. 3(c), suppose the equalizing switch is not used and S_2 and S'_2 exhibits a threshold voltage mismatch of 10 mV. If C_1 = 1 pF, C_2 = 0.5 pF, V_{TH} = 0.6 V, and for all switches WLC_{ox} = 50 fF, calculate the DC offset measured at the output assuming all of the channel charge of S_2 and S'_2 is injected into X and Y, respectively. **(13)**

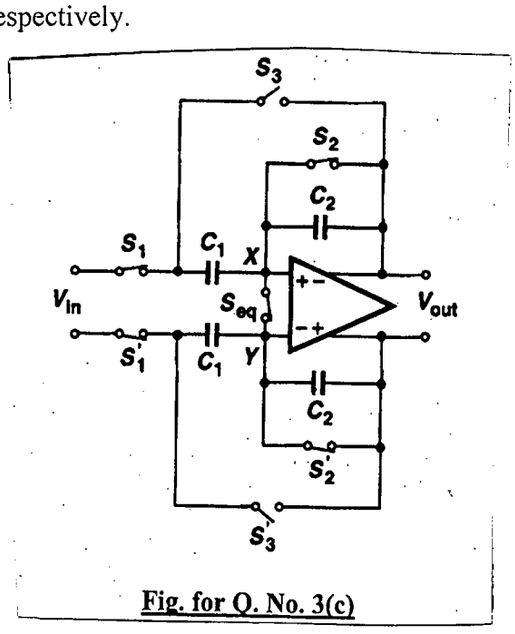

Fig. for Q. No. 3(c)

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4. (a) Show the classification of CMOS Op Amps (Operational Amplifiers). What are the basic requirements for an Op-Amp? Draw the complete model of a non-ideal Op-Amp. **(10)**

(b) Draw a classical two-stage CMOS Op Amp broken into voltage-to-current and current-to-voltage stages and compare it's internal structure with that of a folded cascode CMOS Op Amp. **(10)**

(c) Consider the step response of an Op Amp and mention the boundary conditions for stable operation (i) in time domain, in number of swing (rings) (ii) in criticality of damping and (iii) in phase margin (degree). Mention the name of compensation methods used for Op Amp. Qualitatively draw the effect of compensation on the Bode plot given in the Fig. for .Q. No. 4(c) that will bring the Op Amp in stability. **(15)**

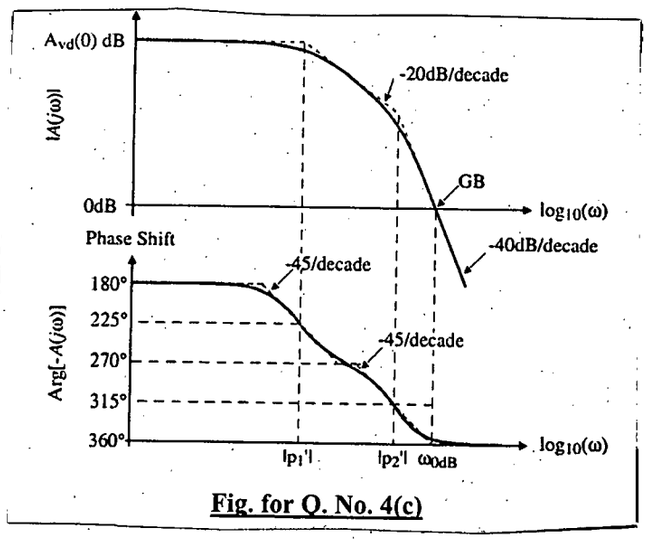


Fig. for Q. No. 4(c)

SECTION-B

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

5. (a) Show that for the differential circuit shown in Fig. for Q 5(a), common-mode rejection ratio (CMRR) can be expressed as **(20)**

$$CMRR = \frac{g_{m1} + g_{m2} + 4g_{m1}g_{m2}R_{SS}}{2\Delta g_m}$$

where notations have their usual meaning and only g_m mismatch is considered.

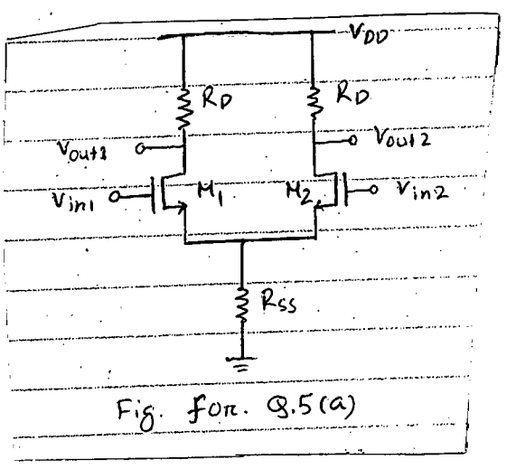


Fig. for. Q.5(a)

EEE 351

Contd... Q. No. 5

(b) In the circuit shown in Fig. for Q 5(b), $\left(W/L\right)_{1,2} = 50/0.5$ **(15)**

(i) What is the maximum allowable output voltage swing if $V_{in,CM} = 1.2V$?

(ii) What is the voltage gain under this condition? Given, $V_{TH} = 0.6$ V, $\mu_n C_{ox} = 50\ \mu A/V^2$, $\lambda = \gamma = 0$ and $V_{DD} = 3V$.

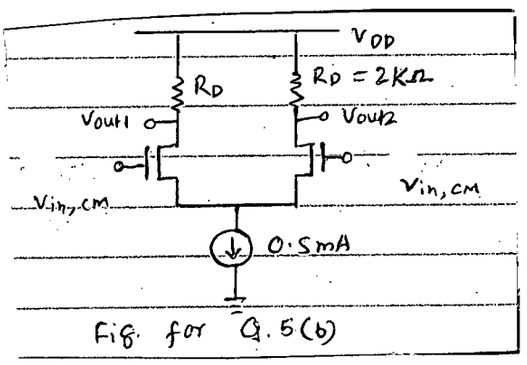


Fig. for Q. 5(b)

6. (a) In the circuit shown in Fig. for Q 6(a), find the drain current of M_4 if all of the transistors are in saturation. Design W/L of the transistors such that I_{out} = 5mA when I_{ref} = 2mA. Also show that $I_1 = \dfrac{\left(W/L\right)_2}{\left(W/L\right)_1} I_{ref}$. **(20)**

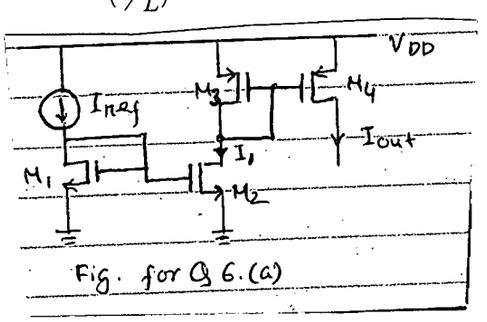


Fig. for Q 6.(a)

(b) In the circuit shown in Fig. for Q 6(b), assuming all the transistors are identical, sketch I_x, V_A and V_B as V_x drops from a large positive value. **(15)**

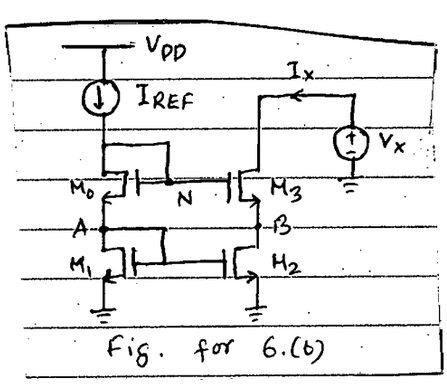


Fig. for 6.(b)

EEE 351

7. (a) For an NMOS current source, calculate the total thermal and $1/f$ noise in the drain current for a band from 100 Hz to 10 MHz. **(13)**

(b) Assuming the transistors in circuit shown in Fig. for Q 7(b), operate in saturation and the circuit is symmetric, calculate the input-referred noise voltage. **(22)**

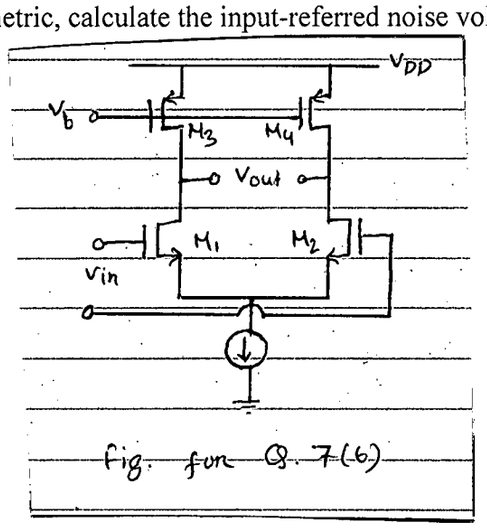


Fig. for Q. 7(b)

8. (a) Draw a circuit diagram to establish supply-independent currents and explain its operation. Show how this circuit can be modified to uniquely define the currents. Also using quantitative analysis, show that the current is independent of the supply voltage in this modified circuit. **(15)**

(b) For the circuit shown in Fig. for Q 8(b), show that V_{BE} exhibits a positive temperature coefficient (TC). Also, show that TC is independent of the temperature. **(12)**

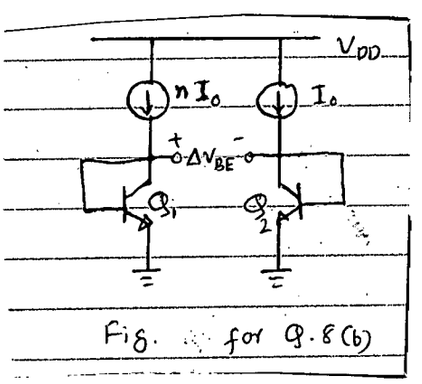


Fig. for Q.8(b)

(c) Op amp offset voltage, V_{OS} contributes to the raise of temperature coefficient of output voltage. Draw a circuit that reduces the effect of V_{OS}. **(8)**

L-3/T-2/EEE **Date : 12/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

Sub : **EEE 331** (Random Signals and Processes)

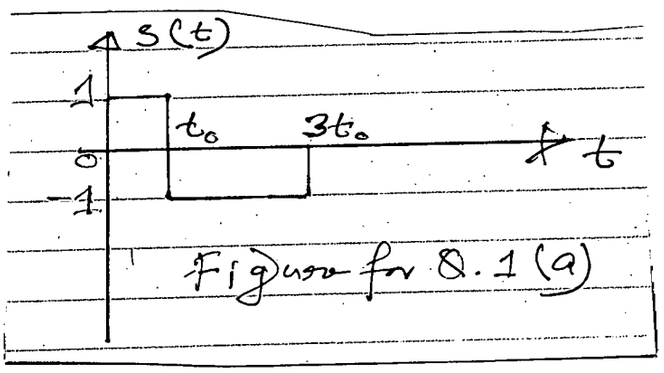
Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

There are **FOUR** questions in this section. Answer any **THREE** questions.
Symbols and abbreviations have their usual meanings.
The questions are of equal value.
Fourier Transform table is attached.

1. (a) A filter receives a deterministic signal s(t), shown below, plus white noise N(t) with power spectral density (PSD) of $N_o/2$ where N_o is a constant. Find the form of the filter that can maximize the SNR at the output of the filter at $t = 3\ t_0$.



Draw the output of the filter. Comment on the form of the filter if N(t) is colored noise with PSD $S_{NN}(w)$.

(b) Prove the Weak Law of large numbers. Comment on its limitations? How does the Strong Law of large numbers complement the limitations? Explain.

2. (a) Consider the random process $X(t) = Y \cos \omega t$ where $Y \sim u(0,1)$. Find the first-order pdf of X(t) for $t = 0, \pi/4\omega, \pi/2\omega$ and π/ω.

(b) A random process X(t) is given by

$$X(t) = A \cos \omega t + B \sin \omega t, \quad -\infty < t < \infty$$

where A and B are uniformly distributed random variables in the range 0 to 1. Develop the conditions necessary to make X(t) WSS.

3. (a) Two random processes are defined as

$X(t) = A \cos(\omega t + \theta)$ A is a constant

$Y(t) = A \sin(\omega t + \theta)$ $\theta \sim u(0, 2\pi)$

Find the cross-correlation functions and cross-power spectral densities of X(t) and Y(t). Comment on your results.

(b) For the random process X(t) in Q. 3(a), determine if it has a derivative in the mean-square sense using its auto correlation function as well as the PSD.

EEE 331

4. (a) Consider the random process Z(t) = A X(t) where A is a random variable that takes on the values ±1 with equal probability. X(t) is a semi-random telegraph signal with $R_{xx}(\tau) = e^{-2\lambda|\tau|}$, and independent of A. Now, Z(t) is applied as input to a differentiator. Find the average power of the output of the differentiator.

(b) X(n) is discrete WSS process and c is a constant. A discrete random process Y(n) = X(n) + c. Find if Y(n) is also WSS. Are X(n) and Y(n) independent, orthogonal and uncorrelated?

SECTION-B

There are **FOUR** questions in this section. Answer any **THREE** questions.
The figures in the margin indicate full marks.

5. (a) A committee of seven people is to be formed from a pool of 10 men and 12 women. **(10)**

(i) What is the probability that the committee will consist of three men and four women?

(ii) What is the probability that the committee will consist of all men?

(b) Three car brands A, B, and C, have all the market share in a certain city. Brand A has 20% of the market share, brand B has 30%, and brand C has 50%. The probability that a brand A car needs a major repair during the first year of purchase is 0.05, the probability that a brand B car needs a major repair during the first year of purchase is 0.10, and the probability that a brand C car needs a major repair during the first year of purchase is 0.15. (10)

(i) What is the probability that a randomly selected car in the city needs a major repair during its first year of purchase?

(ii) If a car in the city needs a major repair during its first year of purchase, what is the probability that it is a brand A car?

(c) Consider the binary symmetrical channel in Fig Q.5(c). It is characterized by inputs x_1 and x_2 and outputs y_1 and y_2. The transitional probabilities are indicated in the figure, where $P_{y/x}$ represents probability of receiving y given that *x* was transmitted. Find $P(x_1/ y_2)$, $P(x_2/ y_1)$, $P(x_1/ y_1)$, $P(x_2/ y_2)$ (15)

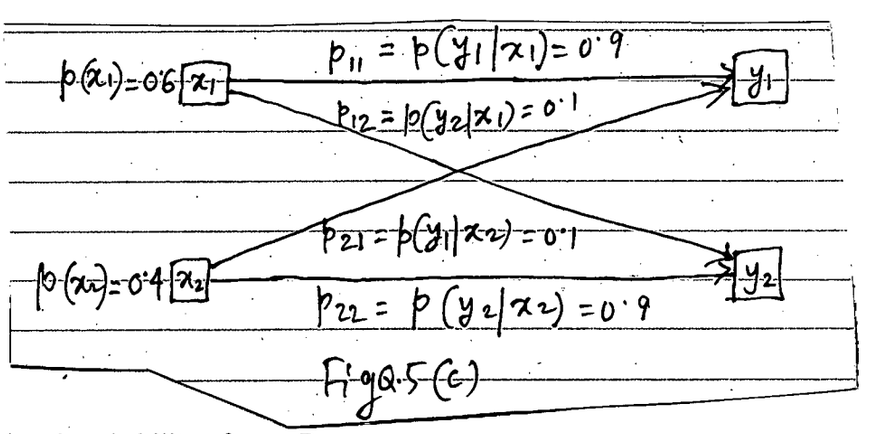


Fig Q.5 (c)

and unconditional probability of error P_e.

EEE 331

6. (a) (i) The random variable X has the following pdf, where K > 0. **(14)**

$$\begin{aligned} f_X(x) &= 0 \quad , \quad x<1 \\ &= K(x-1) \quad , \quad 1\le x\le 2 \\ &= K(3-x) \quad , \quad 2\le x\le 3 \\ &= 0 \quad , \quad x>0 \end{aligned}$$

What is the value of K, sketch $f_X(x)$, what is the CDF of X? What is P[1 ≤ X ≤ 2]?

(ii) A random variable X has the pdf

$$\begin{aligned} f_X(x) &= \frac{1}{3}, \quad 1<x<4 \\ &= 0, \quad otherwise \end{aligned}$$

Use the chebyshev inequality to estimate $P[|x-2.5|\ge 2]$

(b) (i) A random variable X has the pdf $f_X(x)=\frac{x^2}{q}, 0\le x\le 3$. Find the mean, variance and third order moment of X. **(14)**

(ii) The pdf of a continuous random variable X is given by

$$f_X(x)=2e^{-2x}, x\ge 0$$

Find the conditional expected value of X, given that $x\le 3$.

(c) The time that Zakir, the teaching assistant, takes to grade a paper is uniformly distributed between 5 minutes and 10 minutes. Find the mean and variance of the time he takes to grade a paper. **(7)**

7. (a) The joint pdf of two Random variables X and Y is given by **(14)**

$$f_{XY}(x,y)=\begin{cases} k(1-x^2y) & , \quad 0\le x\le 1 \quad 0\le y\ge 3 \\ 0 & , \quad otherwise \end{cases}$$

(i) Find the value of constant *k* that makes $f_{XY}(x, y)$ a true joint pdf.

(ii) Find $f_{X|Y}(x|y)$ and $f_{Y|X}(y|x)$.

(b) A fair coin is tossed four times. Let X denotes the number of heads obtained in the first two tosses and let Y denotes the number of heads obtained in the last two tosses. **(14)**

(i) Find the joint PMF of X and Y, (ii) Show that X and Y are independent Random variables.

(c) The number of emergency calls X to a police station of a certain town has a poisson distribution with mean λ. The probability that any one of these calls is about robbery is p. What is the PMF of Y and the number of calls about robbery? **(7)**

8. (a) X and Y are two independent Random Variables with pdfs, $f_X(x)=4e^{-4x}, x\ge 0, f_Y(y)=2e^{-2y}, y\ge 0$. If we define the Random variable U = X + Y, find the pdf of U and find $P[U>0.2]$. **(14)**

Contd P/4

EEE 331

Contd... Q. No. 8

(b) Find $f_{UW}(u, w)$ in terms of $f_{XY}(x, y)$ if **(14)**
$U = X^2 + Y^2$ and $W = X^2 - Y^2$.

(c) A system consists of one component whose life time is exponentially distributed with a mean of 50 hours. When the component fails, it is immediately replaced by a spare component whose life time is independent and identically distributed as that of the original component without the system suffering a downtime. **(7)**

(i) What is the probability that the system has not failed after 100 hours of operation?

(ii) If the mean lifetime of the component and its spare is increased by 10%, how does that affect the probability that the system exceeds a life time of 100 hours?

Fourier Transform Table

$x(t)$	$X(f)$	$X(\omega)$
$\delta(t)$	1	1
1	$\delta(f)$	$2\pi\delta(\omega)$
$\delta(t-t_0)$	$e^{-j2\pi ft_0}$	$e^{-j\omega t_0}$
$e^{j2\pi f_0 t}$	$\delta(f-f_0)$	$2\pi\delta(\omega-\omega_0)$
$\cos(2\pi f_0 t)$	$\frac{1}{2}[\delta(f-f_0)+\delta(f+f_0)]$	$\pi[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]$
$\sin(2\pi f_0 t)$	$\frac{1}{2j}[\delta(f-f_0)-\delta(f+f_0)]$	$-j\pi[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)]$
$rect(t)$	$sinc(f)$	$sinc\left(\frac{\omega}{2\pi}\right)$
$sinc(t)$	$rect(f)$	$rect\left(\frac{\omega}{2\pi}\right)$
$\Lambda(t)$	$sinc^2(f)$	$sinc^2\left(\frac{\omega}{2\pi}\right)$
$sinc^2(t)$	$\Lambda(f)$	$\Lambda\left(\frac{\omega}{2\pi}\right)$
$e^{-\alpha t}u(t),\ \alpha>0$	$\frac{1}{\alpha+j2\pi f}$	$\frac{1}{\alpha+j\omega}$
$te^{-\alpha t}u(t),\ \alpha>0$	$\frac{1}{(\alpha+j2\pi f)^2}$	$\frac{1}{(\alpha+j\omega)^2}$
$e^{-\alpha\lvert t\rvert},\ \alpha>0$	$\frac{2\alpha}{(\alpha^2+(2\pi f)^2}$	$\frac{2\alpha}{(\alpha^2+(\omega)^2}$
$e^{-\pi t^2}$	$e^{-\alpha f^2}$	$e^{-\alpha f^2}$
$sgn(t)$	$\frac{1}{j\pi f}$	$\frac{2}{j\omega}$
$u(t)$	$\frac{1}{2}\delta(f)+\frac{1}{j2\pi f}$	$\pi\delta(\omega)+\frac{1}{j\omega}$
$\frac{d}{dt}\delta(t)$	$j2\pi f$	$j\omega$
$\sum_{n=-\infty}^{\infty}\delta(t-nT_0)$	$\frac{1}{T_0}\sum_{n=-\infty}^{\infty}\delta\left(f-\frac{n}{T_0}\right)$	$\frac{1}{T_0}\sum_{n=-\infty}^{\infty}\delta\left(\omega-\frac{2\pi n}{T_0}\right)$

L-3/T-2/EEE **Date : 12/03/2018**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2016-2017

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

Full Marks: 210 Time : 3 Hours

USE SEPARATE SCRIPTS FOR EACH SECTION

The figures in the margin indicate full marks.

SECTION – A

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

All the symbols have their usual significance.

1. (a) The machine-2 in a system was delivering 2.0 pu power to an infinite bus and was at a rotor position of 20° before a solid 3-phase fault occurred on a certain line in the system. The machine inertia constant is 8 MJ/MVA on the system base. The system frequency is 50 Hz. The fault was cleared at 0.3 seconds. The power transferability of the machine during the fault and after clearing the fault are respectively as follows.

$P_{e,df} = 0.1545+5.5023 \sin(\delta_2-0.755°)$

$P_{e,af} = 0.1804+6.4934 \sin(\delta_2-0.847°)$

(i) Write the swing equations during and after faults. **(5)**

(ii) Using the step by step algorithm compute t vs. δ_2 starting at t = 0 at an interval $\Delta t = 0.1$ sec and up to 0.4 seconds. In each step you must show detailed calculations of P_a, $kP_{a,n-1}$, $\Delta\delta_{2n}$, δ_{2n}, f_n and put their values in a Table. The symbols have their usual meanings. **(20)**

(b) Explain with the diagram of a relevant shunt FACT device how can you improve stability in case a fault occurs at a generator's terminal? **(10)**

2. (a) Draw the diagrams for monopolar (ground return), monopolar (2-conductors) and bipolar HVDC line models. **(9)**

(b) What will be the DC output voltage of a 3 phase 3 valve rectifier fired at an angle of 30 degrees and connected to the secondary of a 230 kV/120kV transformer? If it were 3 phase six valve rectifier then what would have been the output voltage? **(8)**

(c) Showing the required diagrams and considering the delay and commutation, derive an expression for the DC output voltage of a bridge converter? **(18)**

3. (a) Two power systems A and B are connected by a HVDC link having a loop resistance of 5 ohms. Determine the power transmitted to system B if the rectifier at A is operated with a firing angle of 15°. The transformer connected to each end's 6 valve bridge converter has a leakage reactance of 15 ohms and a secondary voltage of 120 kV. The inverter at B operates on constant β control with an angle of extinction equal to 10° and an angle of commutation equal to 15°. **(10)**

Contd P/2

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Contd... Q. No. 3

(b) Explain with diagrams of the respective series FACTS devices how can you (i) send more power over a long HVAC line without causing significant voltage drop, (ii) limit fault current and (iii) control the power flow in a line. **(15)**

(c) Explain the causes of power loss in an underground cable. **(10)**

4. (a) Explain the PQ events – sag, swell, spike, interruption, harmonics using a diagram. How are these caused? **(15)**

(b) How can you mitigate sag or swell using a dynamic voltage restorer? Explain showing necessary diagrams. **(10)**

(c) Calculate the sag voltage at a 400 kV bus in case a fault occurs at a 33 kV bus when the buses are connected by lines and two layers of step down transformers. Use the following Table. **(5)**

Typical Fault Levels at Different Voltage Levels

Voltage Level	Fault Level (MVA)
400 V	20
11 kV	200
33 kV	900
132 kV	3,000
400 kV	17,000

(d) An electric arc furnace supplied from a 132/11 kV transformer draws 5 kA when its electrodes are shorted in complete melted down condition of the scrap iron. What should be the minimum short circuit level of the 132 kV PCC bus so that the arc furnace does not cause any flicker beyond the borderline of irritation curve. **(5)**

SECTION-B

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

5. (a) What is the effect of unsymmetrical spacing of conductors in a 3-phase transmission line? **(7)**

(b) Derive an expression for inductance of single-phase line consisting of two composite conductors. **(13)**

(c) Each conductor of the bundled-conductor line shown in Fig. for Q. 5(c) is ACSR, 1,272,000-cmil Pheasant. Find the inductive reactance in ohms per kilometer per phase for d = 45 cm. Also find the per unit series reactance of the line if its length is 160 km and the base is 100 MVA, 345 kV. Given that the GMR of the individual conductors composing the bundle is 0.0466 ft. **(15)**

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

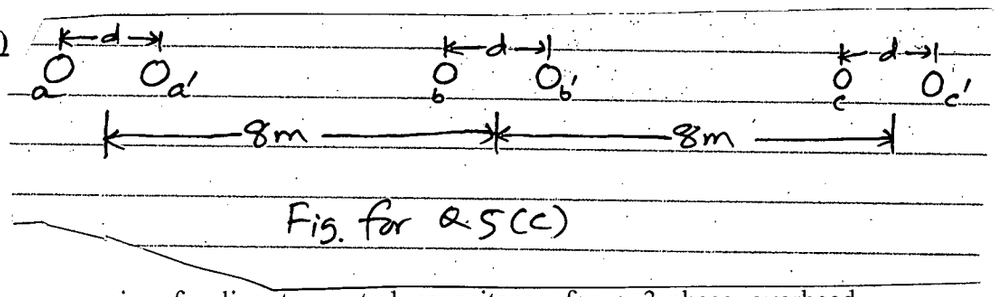

Fig. for Q 5(c)

6. (a) Deduce an expression for line to neutral capacitance for a 3-phase overhead transmission line when the conductors are (i) symmetrically placed (ii) unsymmetrically placed but transposed. **(10+10)**

(b) A 3-phase, 50Hz, 66kV overhead line conductors are placed in a horizontal plane as shown in Fig. for Q. 6(b). The conductor diameter is 1.25 cm. If the line length is 100 km, calculate (i) capacitance per phase, (ii) charging current per phase, assuming complete transposition of the line. **(15)**

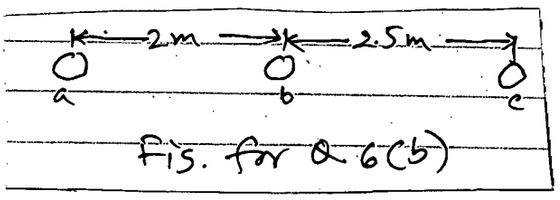

Fig. for Q 6(b)

7. (a) Derive the swing equation for two non-coherent machines in a power system. **(10)**

(b) Two 60 Hz generating units operate in parallel within the same power plant and have the following ratings: **(10)**

Unit 1: 500 MVA, 0.85 power factor, 20 kV, 3600 r/min, H_1 = 4.8 MJ/ MVA.

Unit 2: 1333 MVA, 0.9 power factor, 22 kV, 1800 r/min, H_2 = 3.27 MJ/ MVA.

Calculate the equivalent H constant for the two units on a 100 MVA base.

(c) Calculate the critical clearing angle and the critical clearing time for the system of Fig for Q. 7(c) when the system is subjected to a 3-phase fault at point P on the short transmission line. Given that H = 5 MJ/MVA. **(15)**

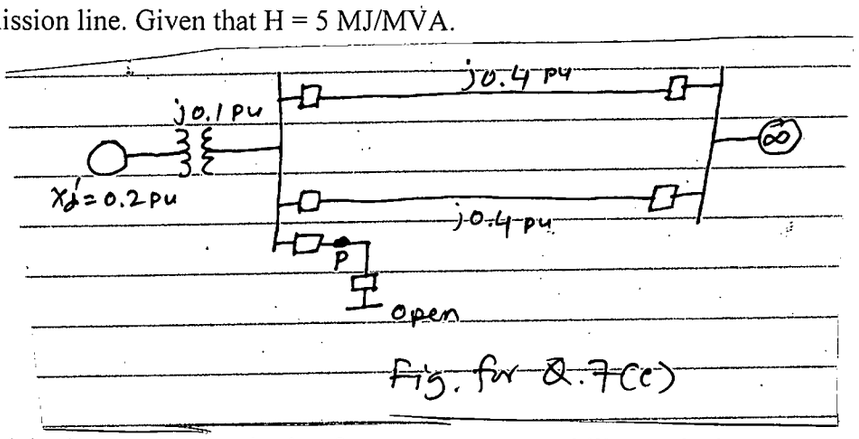

Fig. for Q.7(c)

8. (a) Explain the equal area criterion for power system stability analysis. **(11)**

(b) Write short notes on the followings: **(3×8=24)**

(i) Effect of earth on the capacitance of 3-phase transmission line.

(ii) Flux linkage of one conductor in a group.

(iii) Inductance of a 3-phase transmission line with bundled conductors.
