L-3/T-2/EEE Date : 09/06/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

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**.

1. (a) Consider the message signal, $m(t) = 10\cos 2000\pi t + 10\cos 4000\pi t$. The message signal is sampled and then passed through a flat-top filter having impulse response $h(t) = \Pi\left(\frac{t}{\tau}\right)$ to obtain a PAM signal, where τ is the width of a pulse. What is the minimum sampling rate to recover the message signal from the PAM signal? Assuming the sampling rate of the message signal is 8000 Hz, draw the frequency spectra of the PAM signal for (i) τ = 0.5 ms, (ii) τ = 0.1 ms and (iii) τ = 0.05 ms. If there is no equalizer at the receiver then which value of τ will you choose for transmission and reception of the message signal using PAM technique? Write down the expressions of the transfer functions of the equalizers for three values of τ. Which flat-top filter and equalizer will you choose and why? **(18)**

(b) What are the differences between multiplexing and multiple access? Twenty voice source need to be multiplexed using TDM. The bandwidth of each source is 4 kHz. What should be the sampling rate of the commutator of the TDM circuit? What is the bandwidth of the TDM signal if instantaneous sampling with pulse width $\tau \to 0$ is considered? How the bandwidth of the TDM signal can be reduced? What is the required bandwidth if FDM is used instead of TDM? **(10)**

(c) Compare among the unipolar NRZ, polar NRZ, unipolar RZ, AMI and Manchester line coding techniques in terms of their merits and demerits. **(7)**

2. (a) What are the limitations of delta modulation? How the limitations can be minimized? **(7)**

(b) A communication system with delta modulation can support maximum data rate of 5 kbps. The message signal to be transmitted is shown in Fig. for Q. 2(b). Determine the value of the level height Δ for which both the slope-overloading and granular noises are minimized and the system have the maximum data rate. **(10)**

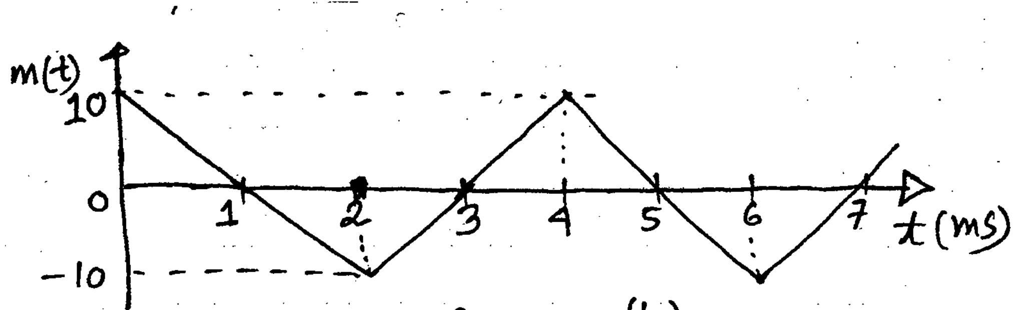

Fig. for Q. 2(b)

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Contd... Q. No. 2

(c) The message signal $m(t) = 10\cos 2000\pi t$ is sampled at 300% higher rate than the Nyquist rate for DPCM. The maximum value of the error signal of DPCM is found to be 2. Determine the bit rate of DPCM to achieve signal to quantization noise ratio (SQNR) of 30 dB. What will be the SQNR if PCM is used instead of DPCM with the same no. of levels in quantization? **(18)**

3. (a) Draw the block diagrams of QPSK modulator and demodulator. Draw the typical waveshapes of all the signals that exist at different points of modulator and demodulator for an input data stream x = [10011100]. **(20)**

(b) The symbol duration and the received energy per symbol of ASK, BPSK and QPSK modulation and demodulation (coherent) schemes are taken to be 1 μs and 10^{-18}J. The energy of noise per bit is 10^{-19}J. Determine the data transmission rate and bit error rate (BER) for each of the modulation schemes. If the duration of symbols are doubled for QPSK modulation keeping the same received power, what will be the data transmission rate and BER for this modulation? The Q-function can be approximated as **(15)**

$Q(x) \approx \frac{1}{x\sqrt{2\pi}}\left(1 - \frac{0.7}{x^2}\right)e^{-x^2/2}$. Also comment on the results.

4. (a) Compare among the TDMA, FDMA and CDMA systems in terms of their merits and demerits. **(12)**

(b) There are two transmitter-receiver pairs in a DS-CDMA system. The transmitters and receivers use 4 chip Walsh Codes. For bit sequences $x_1 = \{101\}$ and $x_2 = \{110\}$ of the transmitters, draw the waveshapes of the transmitted signal of each transmitter and the received signal, decoded signal and decoded bit sequence at each receiver. **(18)**

(c) Write down the advantages and disadvantages of DSSS and FHSS techniques. **(5)**

SECTION – B

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

5. (a) Define modulation index for an AM signal. Comment on the limitations of DSB-SC modulation and the ways to overcome them. Draw an AM waveform for tone modulation when f_c = 10 KHz, f_m = 100 Hz, carrier amplitude is 3 V, and μ = 1.1. Here, the symbols denote their usual meaning. The figure must be clearly labeled and drawn approximately in scale. How can you recover the modulating signal from this waveform using envelope detection? **(20)**

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Contd... Q. No. 5

(b) A general communication channel supports 60 users, is able to allocate a bandwidth of 4 KHz to each user, and has a channel SNR of 9 dB. If suddenly the number of users is quadrupled, and as a result, channel noise power is tripled, how can you keep the channel capacity from being affected? Assume that signal power for the scheme can not be changed. **(15)**

6. (a) What are the benefits of using switching modulators in an AM system? Explain the differences between diode-bridge and ring modulators with diagrams. **(14)**

(b) Give real-life examples of different types channel (media) available to a general communication system. **(6)**

(c) Explain the role of and the relationship between vestigial and equalizer filters in VSB modulation. For a VSB modulator, the vestigial filter $H_i(\omega)$ has a transfer function which is shown in the figure below. The baseband signal bandwidth is 4 KHz and carrier frequency is 10 KHz. Find the corresponding transfer function of the equalizer filter $H_O(\omega)$ needed in a VSB receiver for distortionless reception. The figures must be clearly labeled and drawn in scale. **(15)**

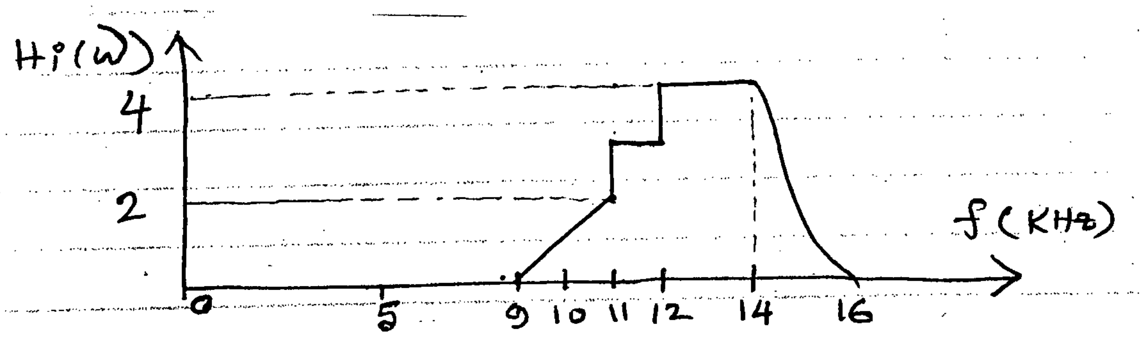

Fig. for Q. 6(c)

7. (a) Derive the expression of a narrowband FM signal and compare it with the expression of an AM signal. Discuss how a narrowband FM signal can be generated with AM transmitter components. Also, explain why the concept of 'complex envelope' is necessary to define a wideband FM system. **(18)**

(b) A carrier wave of frequency 100 MHz is frequency-modulated by a sinusoidal wave of amplitude 20 V and frequency 100 KHz. The frequency sensitivity of the modulator is 25 KHz per volt. **(17)**

   (i) Determine the approximate bandwidth of the FM signal using Carson's rule.

   (ii) Determine the bandwidth by transmitting only those side frequencies whose amplitudes exceed 1 percent of unmodulated carrier amplitude.

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Contd... Q. No. 7(b)

(iii) Is there any other way to estimate the FM signal bandwidth?

(iv) Repeat the calculations if modulating signal amplitude is doubled.

(v) Repeat the calculations if modulation frequency is doubled.

Necessary curves for this question is attached.

8. (a) Explain the operation of a Foster-Seeley detector with circuit and phasor diagrams. **(12)**

(b) (i) A sinusoidal signal, with an amplitude of 3.25 V, is applied to a uniform quantizer of the midtread type whose output takes on the values of 0, ±1, ±2, ±3 volts. Sketch the waveform of the resulting quantizer output for one complete cycle of the input. If other parameters are needed, assume suitable values for them. **(9)**

(ii) Repeat the evaluation when the quantizer output takes on the values of ±0.5, ±1.5, ±2.5, ±3.5 volts. What will be the type of this form of uniform quantizer?

(c) The signal $m(t) = 6\sin(2\pi t)$ volts is transmitted using a 4-bit binary PCM system. It uses a midrise quantizer with 1 volt step size. Sketch the resulting PCM wave for one complete cycle of the input. Assume a sampling rate of four samples per second, with samples taken at $t = \pm 1/8, \pm 3/8, \pm 5/8, \ldots$ seconds. **(14)**

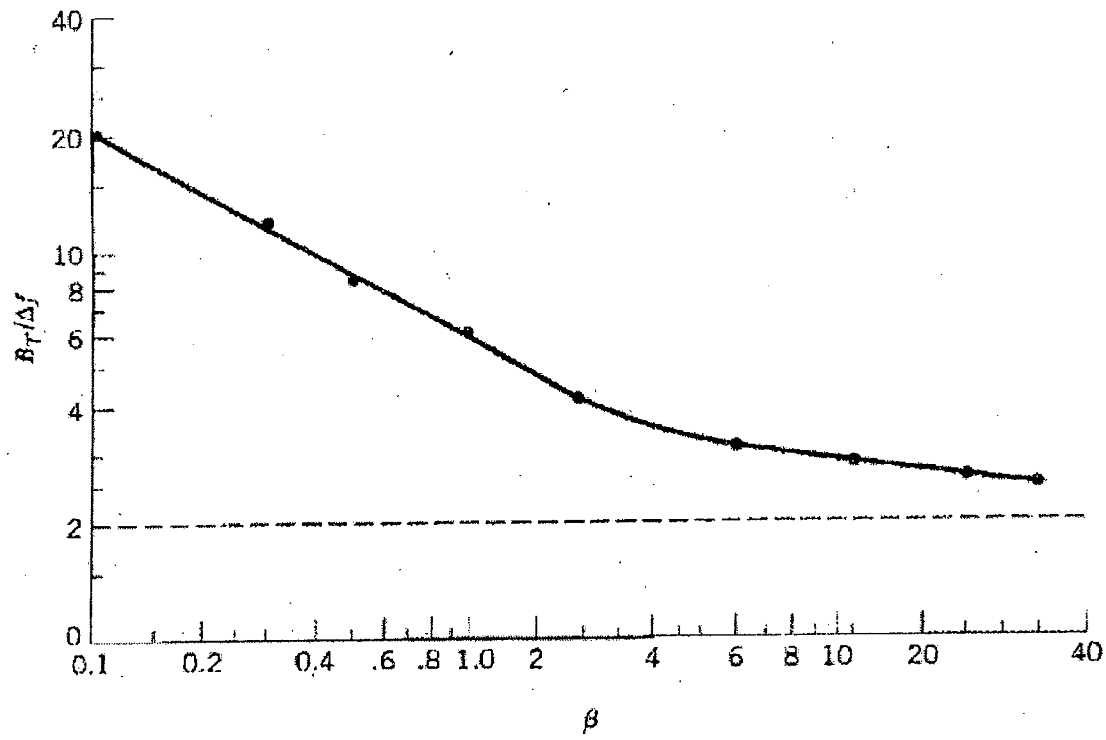

Fig. for Q. 7(b).

L-3/T-2/EEE Date : 19/05/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

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**.

Assume reasonable data if necessary. Symbols used have their usual meanings.

Provide necessary comments in assembly language codes.

1. (a) Explain how does an 8086 microprocessor read data from or write data to an odd addressed memory location. Provide suitable examples. **(10)**

   (b) Design an 8086 based system to implement interrupts of type 47 and 93. Choose suitable base address(es) from the range FEF0H – FEFFH. Show the system connection. Design the address decoder using basic logic gates. Write an appropriate assembly code snippet for initialization of this system. **(20)**

   (c) Why is it necessary to send an End of Interrupt (EOI) command to an 8259A at some time in an interrupt-service routine? **(5)**

2. (a) Design a display board containing 8 common cathode (CC) seven segment displays (SSD), which are to be operated using multiplexing technique. Use only PORTB of an 8255 A PPI (with base address 9A59H) for multiplexing and transmitting data from an 8086 microprocessor based system to the display board. Assume that each segment consumes 25 mA at 1.5 V. Show the connection between the board and PORTB of the 8255A. **(15)**

   (b) Write an interrupt service routine in 8086 assembly language which will refresh the display board. Assume that the procedure will be called every 2 ms by an interrupt signal to IR3 of an 8259A. Also assume that data to be displayed is taken from an 8 element byte array named DISPLAY_DATA. **(10)**

   (c) Describe the procedure that an 8086 microprocessor will follow when it responds to an interrupt. **(10)**

3. (a) Suppose that an 8254A timer/counter IC is to be connected and programmed in such a way that it produces an interrupt in every 20 ms. This interrupt signal has interrupt type 47 and is to be connected to one of the IR inputs of an 8259A PIC. Assume the base address for the 8254A is FEF1H and that for 8259A is FEF0H. The input clock frequency for 8254A is 4.9152 MHz. **(20)**

Contd P/2

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

(i) Show the system connection between 8254A and 8259A with appropriate address decoding for both.

(ii) Which IR input of 8259A is to be connected with this interrupt signal?

(iii) Write an assembly code snippet to initialize the 8254A IC for this desired operation.

(b) Explain why it is necessary to initialize an 8251A USART with a worst-case initialization sequence. **(8)**

(c) How can you step through the instructions of an interrupt service routine? Explain. **(7)**

4. Suppose that two computers are to be connected to each other through two 8251A USARTs. The base address for the USART of system-I is F0E0H and that for system-II is FCF0H. The input clock frequency for both USARTs is 614.4 kHz.

(a) Show the connection diagram between 8086 microprocessor buses and USART for both systems (Address decoder circuit is not required) and between the USARTs. **(12)**

(b) A serial communication is to be established with 9600 bauds per second, 7 bit character length, one stop bit, even parity, enabled error reset, disabled hunt mode and no break character. Choose other options as the situation demands. Construct the mode and command words that must be sent for the USART of system-I. **(8)**

(c) Write an assembly language procedure for system-II to receive a ten character string from system-I using polling method. Keep provision for checking parity, framing and overrun error (assume that another procedure RESEND_DATA will be called if any error occurs; you need not write this procedure, just use it whenever it is necessary.) **(10)**

(d) Assume that an 8254 IC is to be used to generate the desired USART clock frequency from a source clock frequency of 11.0592 MHz. Write an assembly language code snippet to initialize the 8254 for this purpose. Assume the 8254 has the base address FB00H. **(5)**

SECTION – B

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

5. (a) "8086 is a 16-bit microprocessor" — Explain. **(10)**

(b) Explain using example, how 20-bit physical address is accessed by 16 bit registers. **(10)**

(c) Determine the values of CF, SF, ZF, PF and OF for the following instructions. Assume that the flags are initially 0 for each part. **(15)**

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

(i) NEG AX; where AX contains 8000H

(ii) SUB AX, BX; where AX contains 800H and BX contains 0001H

(iii) RCR AX, 1: where AX contains A055H

(iv) MUL BL; where AL contains 80h and BL contains FFH

(v) TEST AX, 0FFFFH; where AX contains 0000H.

6. (a) Point out the errors in the following code segment and explain the reasons: **(10)**

```
      MOV AL, 05H
      MOV BX, AL
      MUL 10
      MOV [BX], 1
      MOV SI, 0FH
      ADD AX, 2[SI]
      PUSH AL
DONE?: SHL AL, 2
      TEST AL, AL
      JZ DONE?
      HLT.
```

(b) Write an assembly code to test whether the number stored in AX is a perfect square or not. If it is a perfect square, put 1 in DX, otherwise make it 0. **(10)**

(c) Write an assembly code, that will insert STRING2 into STRING1 at a point specified by CX. For example, STRING1 = PRAM, STRING2 = ROG, CX = 1. After execution, STRING1 = PROGRAM. **(15)**

7. (a) Determine the addressing modes of each operand of the following instruction. **(5)**

(i) MOV BX, [BX]

(ii) ADD AX, 5

(iii) MOV AX, 2 + [SI]

(iv) MOV AX, W + [BX]; W is a word variable

(v) ADD AX, 5 [W+BX + SI]; W is a word variable

(b) Assume that CT is a byte type array which contains 4 class test numbers of a student. Write an assembly code to find the average number of the best three class tests, which will be stored in AL. If the average is a fraction number, then the result should be rounded version of the average. **(15)**

Contd P/4

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Contd... Q. No. 7

(c) Assume that A and B are two word type array which contain two 2×2 matrices. Write an assembly code to check whether B is inverse matrix of A. If yes, make CX = 1 and 0, otherwise. Remember that, $AA^{-1} = I$, where I is an identity matrix of same order. **(15)**

8. (a) What are the differences between a microprocessor and a microcontroller? **(5)**

(b) Assume, we have a microcontroller (e.g. ATMega 32) and four seven segments and two push buttons. We want to design a manual car counter display for a parking lot. The seven segment displays will show the number of cars in the parking lot. If the operator presses button "one", the display will show increase in the number of car. If any car leaves, the operator will press button "two" and the display will be changed accordingly. If the count reaches 1000, which is the limit for parked car, the display will show 'FULL'.

(i) Draw the connection diagram to implement the design. **(10)**

(ii) Write the algorithm which you want to use. **(10)**

(iii) Write a C code which will perform the desired operation. **(10)**

8259A 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
ICW3 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

8254 Control Word:

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

8255A PPI Mode Set Control Word:

D7	D6	D5	D4	D3	D2	D1	D0
Mode set Flag	PORTA MODE		PORTA I/O	PORTC (U) I/O	PORTB MODE	PORTB I/O	PORTC (L) I/O

8259A Mode Word:

D7	D6	D5	D4	D3	D2	D1	D0
S2	S1	EP	PEN	L2	L1	B2	B1

8259A Command Word:

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

8259A Status Word:

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

L-3/T-2/EEE

Date : 26/05/2014

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

Symbols have their usual meanings.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) A random process $X(t)$ is given by $X(t) = Ae^{j(w_o t+\theta)}$ where A and w_o are arbitrary constants and θ is a uniform random variable over 0 to 2π. Find (i) $\mu_x(t)$, (ii) $R_{xx}(t_1,t_2)$ and (iii) $C_{xx}(t_1,t_2)$. Is the process wide-sense-stationary (WSS)? **(20)**

(b) A WSS process, $X(t)$ has an average power of 11. Give reasons why the following functions can or cannot be its auto correlation function: **(15)**

(i) $R_{xx}(\tau) = \dfrac{\tau^2+44}{\tau^2+4}$, (ii) $R_{xx}(\tau) = \dfrac{11e^{j2\tau}}{1+\tau^2}$, (iii) $R_{xx}(\tau) = \dfrac{11\tau^2}{1+3\tau^2+4\tau^4}$

(iv) $R_{xx}(\tau) = \dfrac{10\, Cos\,\tau}{1+3\tau^2+4\tau^4}$.

2. (a) A zero mean random process, $Y(t)$ has the following autocorrelation function.

$$R_{YY}(\tau) = B\,Cos(\omega_o \tau)$$

Where B and w_o are arbitrary constants. Find if $Y(t)$ is mean-ergodic and correlation ergodic in the mean square sense. **(20)**

(b) Consider the following two random processes (i) $X(t) = At + B$ where A and B are uniform and independent random variables over $(-1, 1)$; and $Y(t) = e^{-\alpha t}X_1(t)$ where $X_1(t)$ is a zero mean Gaussian process and covariance of $X_1(t)$ is $e^{\alpha t}$.

Find whether the processes $X_1(t)$ and $Y(t)$ are stationary in strict sense. **(15)**

3. (a) The signal received at the receiver of a RADAR is $X(t) = S(t) + n(t)$ where $n(t)$ is a WSS white noise process with $S_{NN}(\omega) = 10$ and $S(t)$ is a deterministic quantity and shown in Fig. for Q. No. 3(a).

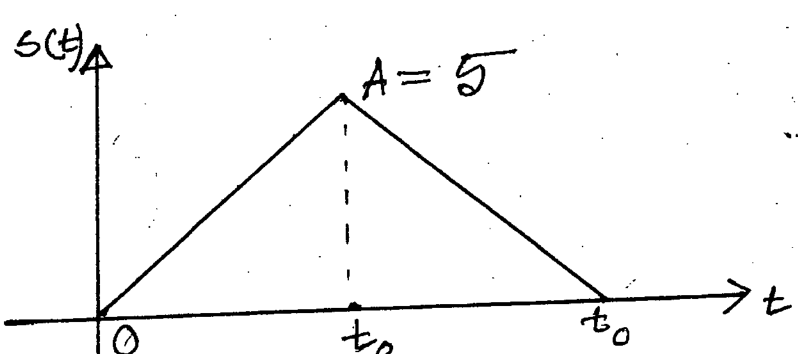

Fig. for Q. No. 3(a)

Contd P/2

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

Find the impulse response of a filter that may be used to detect the presence of $S(t)$ in $X(t)$ by maximizing the signal-to-noise ratio (*SNR*) at $t = t_0$. Also, give the condition for the filter to be causal.

If $S_{NN}(\omega) = \frac{4+\omega^2}{1+\omega^2}$, then derive the impulse response of the pre-whitening filter. The filter has to be causal and stable. **(20)**

(b) $X(n)$ is a *WSS* discrete random process. Find $R_{YY}(n)$ where $Y(n) = X(n) + c$; c being an arbitrary constant. Also, determine if X and Y are independent, orthogonal and uncorrelated. **(15)**

4. (a) A *WSS* random process $X(t)$ is input to the linear-time-invariant (LTI) filters $h_1(t)$ and $h_2(t)$ shown in Fig. for Q. No. 4(a):

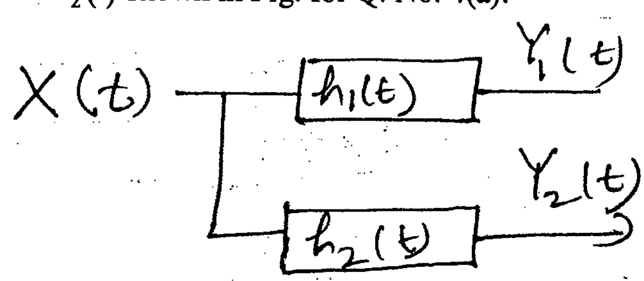

Fig. for Q. No. 4(a).

Given that $S_{XX}(\omega) = 10$; $h_1(t) = 1$ *for* $0 \le t < 1$ and zero otherwise, and $h_2(t) = 2e^{-t}\, u(t)$, *find* (i) $R_{Y_1Y_1}(\tau)$ (ii) $R_{Y_2Y_2}(\tau)$ and $R_{Y_1Y_2}(t, t+\tau)$. Also, calculate the average power of Y_1 and Y_2. **(20)**

(b) A system consists of two independent components *X* and *Y* that are connected in parallel. The component *X* is built using 48 similar electronic chips, where *Y* is comprised of 64 similar electronic chips. The life time (in hours) of a chip is a uniform random variable distributed over 1 to 4. Assume that the chips are all independent in terms of life time. Find the mean life times of *X* and *Y*. Next, determine the probability that the system has not failed after 135 hours of operation. **(15)**

SECTION – B

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

5. (a) A box containing 20 light bulbs has 4 of them to be defective. Two bulbs are removed at random without replacement. **(17)**

    (i) What is the probability that the first one is good and second one defective?

    (ii) Determine whether the events

    G_1 = "first bulb is good ", and

    D_2 = "second bulb is defective" are independent.

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Contd ... Q. No. 5

(b) A manufacturing process produces a mix of good and bad products. The fraction of good products is (1 – p) and that of bad products p. The life time of both good products and bad products follow exponential law with rates of failure α and 1000 α, respectively. **(18)**

(i) Find the probability that a randomly selected product is still functioning after t seconds.

(ii) In order to control the shipment of bad products, every product is tested for t seconds prior to leaving the factory. The products that fail are discarded, and the remaining products are sent out to the customers. Find the value of *t* for which 99% of the products sent out to customers are good.

6. (a) A student needs 10 chips of a certain type to build a circuit. It is known that the probability for a chip to be non-defective is only 95%. How many chips should the student buy for there to be a greater than 90% probability of having enough chips for the circuit? **(18)**

(b) The number *N* for requests of telephone connection is a Poisson random variable with λ, the average rate of requests for connections, as 30 requests/minute. Find the probability of the following events: **(17)**

(i) More than 5 requests for connection in 10 seconds.

(ii) Fewer than 3 requests for connection in 2 seconds.

7. (a) The probability distribution function of a random variable *X* is shown in the Fig. for Q. No. 7(a). Find the following probabilities. **(17)**

(i) $P[X \le 0]$

(ii) $P[0.25 \le X < 1]$

(iii) $P[0.25 \le X \le 1]$

(iv) $P[X > 0.5]$

(v) $P[X \ge 0.5]$

(vi) $P[X < 5]$

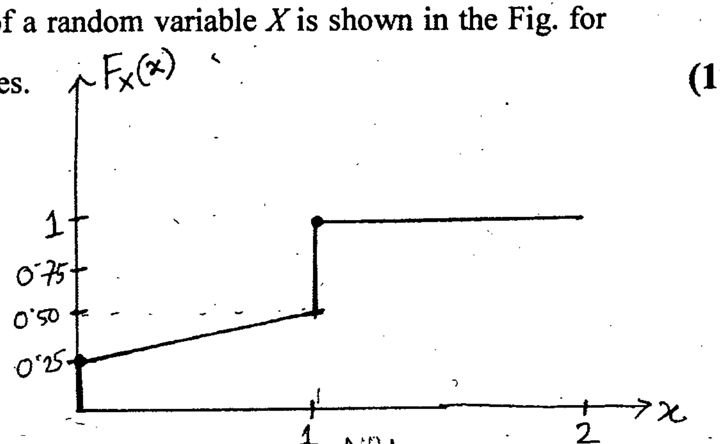

Fig. for Q. No. 7(a)

(b) A random variable *X* has the following probability density function: **(18)**

$$f_X(x) = \begin{cases} cx(1-x) , & 0 \le x \le 1 \\ 0 , & otherwise \end{cases}$$

(i) Find c and sketch $f_X(x)$

(ii) Find and sketch the corresponding $F_X(x)$

(iii) Find $P\left[\frac{1}{2} \le X \le \frac{3}{4}\right]$

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8. (a) The joint probability density function of two random variables X and Y is given by

$$f_{XY}(x, y) = \begin{cases} 6x, & x > 0, \quad y > 0, \quad 0 < x + y \leq 1 \\ 0, & \textit{otherwise} \end{cases}$$

Define the random variable $Z = X - Y$. **(17)**

(i) Find the probability density function of Z.

(ii) Find the conditional probability density function of Y given X.

(iii) Determine Var $\{X + Y\}$

(b) Let X and Y independent exponential random variables with common parameter λ. Define $U = X + Y$, $V = X - Y$. **(18)**

(i) Find the marginal probability density function of U and V given that

$$f_{XY}(x, y) = \frac{1}{\lambda^2} e^{-(x+y)/\lambda}, \quad x > 0, \; y > 0$$

(ii) Verify if random variables U and V are independent.

(iii) Verify if U and V are uncorrelated random variables.

Fourier Transform Table

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

Table Z: Areas under the standard normal curve (positive Z)

	Second decimal place in z									
z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990
3.1	0.9990	0.9991	0.9991	0.9991	0.9992	0.9992	0.9992	0.9992	0.9993	0.9993
3.2	0.9993	0.9993	0.9994	0.9994	0.9994	0.9994	0.9994	0.9995	0.9995	0.9995
3.3	0.9995	0.9995	0.9995	0.9996	0.9996	0.9996	0.9996	0.9996	0.9996	0.9997
3.4	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9997	0.9998
3.5	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998	0.9998
3.6	0.9998	0.9998	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.7	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.8	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999	0.9999
3.9	* 1.0000									

* For values of z ≥ 3.90, the areas are 1.0000 to four decimal places

L-3/T-2/EEE **Date : 26/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

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

Full Marks : 210 Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Can different types of internal noises which corrupt signals processed by integrated circuits (ICs) be treated as white noise? Explain the origins of these internal noises and draw their spectrum. What is the significance of the corner frequency of this spectrum? Draw layouts of MOSFET showing the techniques of reducing gate resistance. **(12)**

   (b) Describe various methods for the representation of internal noise in a circuit. **(11)**

   (c) Determine the input-referred noise voltage for the circuit shown in Fig. for Q. No. 1(c). **(12)**

2. (a) Illustratively explain how to define the currents of a supply-independent biasing circuit. Referring Fig. for Q. No. 2(a) derive the expression for I_{out}. **(10)**

   (b) Explain how the start-up circuit shown in Fig. for Q. No. 2(b) operates. Derive a relationship that guarantees $V_X < V_{TH}$ after the circuit turns on. **(10)**

   (c) What is a band-gap reference? Consider the self-biased cascode shown in Fig. for Q. No. 2(c). Determine the minimum and maximum values of RI_{REF} such that M_1 and M_2 remain in saturation. **(15)**

3. (a) Draw necessary circuits and explain how the charge is transferred between the 'sampling' and 'amplifying' modes of a switched-capacitor amplifier. **(10)**

   (b) Discuss various disadvantages/ problems related to precision MOS switches and suggest remedies for those problems. **(15)**

   (c) Discuss the problems of a discrete-time integrator. Draw and explain the operation of a parasitic-insensitive integrator both in the sampling mode and in the integration mode. **(10)**

4. (a) Explain the conceptual operation of the phase/frequency detector (PED) shown in the Fig. for Q. No. 4(a), by drawing the sequence diagrams showing phase mismatch and frequency mismatch. **(8)**

   (b) Explain the operation of a charge-pump PLL. Why 'zero' is required to be added to this CP-PLL? **(8)**

   (c) Address the following non-ideal effects in a PLL while implementing the charge pump by MOSFETs: (i) effect of skew between $\overline{Q}_A$ and Q_B (ii) suppression of skew. **(12)**

   (d) What is a DLL? Write short note on (i) skew reduction (ii) jitter reduction. **(7)**

Contd P/2

EEE 351

SECTION – B

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

5. (a) Define transconductance of a MOSFET. Show variation of transconductance as a function of overdrive voltage and drain current with necessary equations and figures. **(15)**

(b) What is channel length modulation? How do drain current and transconductance are affected by this? **(10)**

(c) Draw the complete MOS small signal equivalent circuit. Derive expressions for r_o and g_{mb}. **(10)**

6. (a) Show that the gain for common source stage with diode connected load is given by

$$A_V = -\sqrt{\frac{(W/L)_1}{(W/L)_2}}\frac{1}{1+\eta}$$

where the symbols have their usual meaning. **(18)**

(b) In the cascade stage of Fig. for Q. No. 6(b) assume $(W/L)_1 = 50/0.5$, $(W/L)_2 = 10/0.5$, $I_{D1} = I_{D2} = 0.5$ mA and $R_D = 1\ k\Omega$, $V_t = 0.7$ V, $\lambda = \gamma = 0$, $\mu_n = 350\ cm^2/V\text{-}S$, $t_{ox} = 9$ nm, $\varepsilon_{ox} = 3.9$. Find the value of V_b such that M_1 is 50 mV away from triode region.

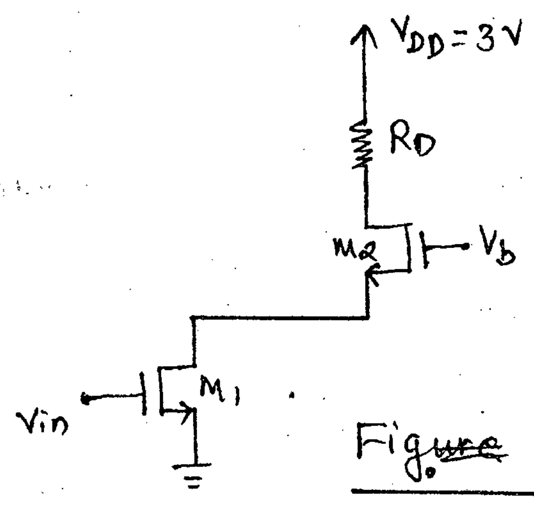

Figure for Q. No. 6(b)

7. (a) For the differential pair shown in Fig. for Q. No. 7(a) and 7(b), derive expression for G_M, using large signal analysis. **(18)**

Contd P/3

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Contd ... Q. No. 7

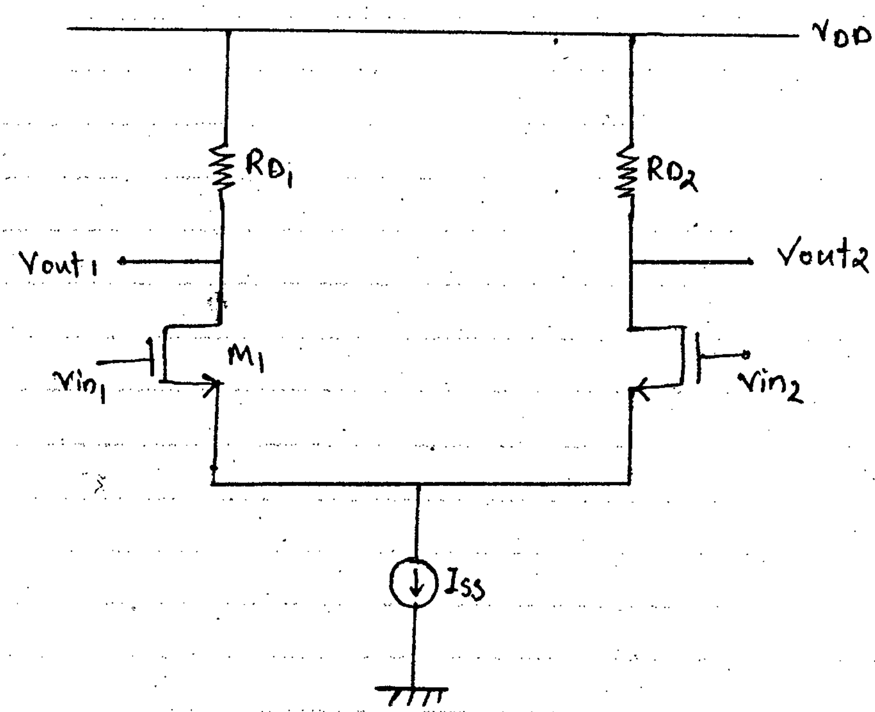

Figure for ques. 7(a) & 7(b). Q. No.

(b) If the differential pair shown in Fig. for Q. No. 7(a) and 7(b), uses a resistor instead of current source to define a tail current of 1.5 mA,

(i) What is the required input CM for which the tail resistor R_{ss} sustaining 0.75 V?

(ii) Calculate RD for a differential gain of 10.

(iii) What happens at the o/p if the i/p CM level is 50 mV higher than the value calculated in (i)?

Assume, $(W/L)_{1,2} = 50/0.5$, $\mu_n C_{ox} = 50\ \mu A/V_2$, $V_{TH} = 0.7V$, $\lambda = \gamma = 0$ and $V_{DD} = 5$ V. **(17)**

8. (a) For the active current minor shown in Fig. for Q. No. 8(a), show that the gain can be expressed as $A_V = \frac{g_{m2}}{2}\left[(2r_{O_2}) \| r_{O_4}\right]$ **(20)**

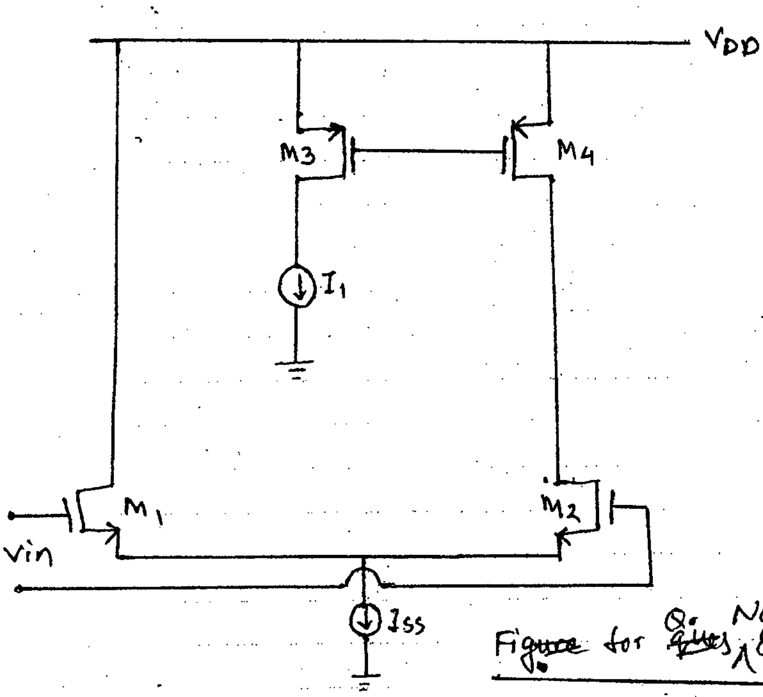

Figure for Q. No. ques. 8(a)

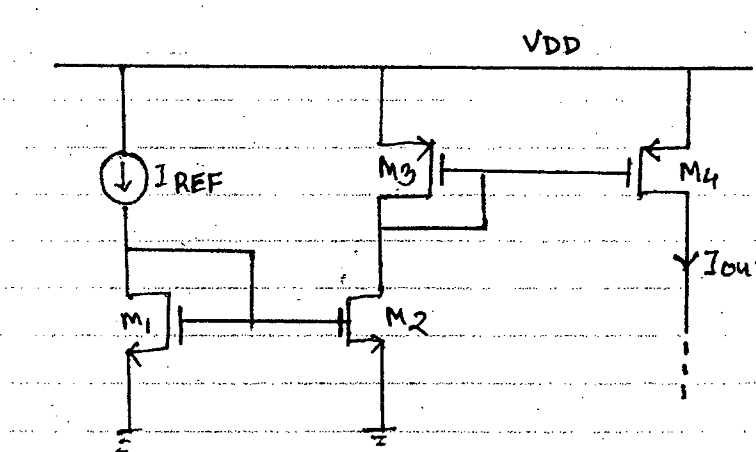

Figure for Q. No. ques. 8(b)

(b) In Fig. for Q. No. 8(b) find I_{out}, if all the transistor are in saturation. Assume $\lambda = 0$, $(W/L)_1 = 50/0.4$, $(W/L)_2 = 100/0.5$, $(W/L)_3 = 50/0.5$ and $(W/L)_4 = 100/4$. **(15)**

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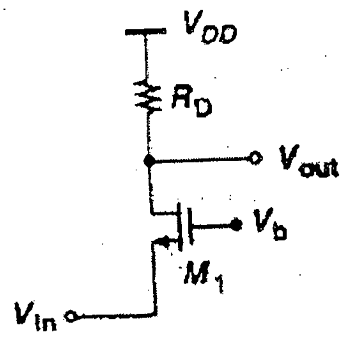

Fig. for Q. No. 1(c)

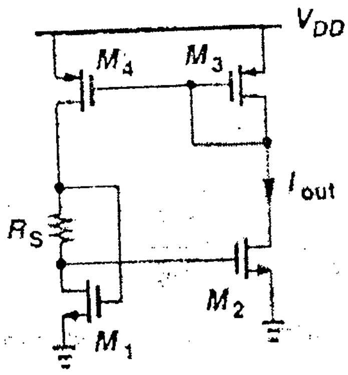

Fig. for Q. No. 2(a)

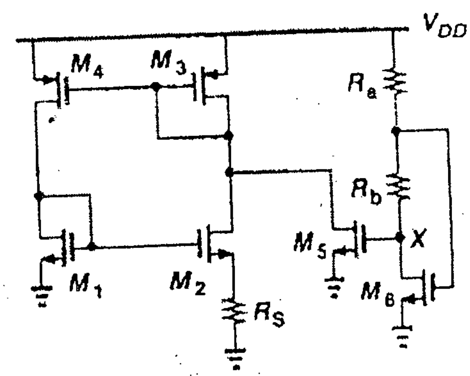

Fig. for Q. No. 2(b)

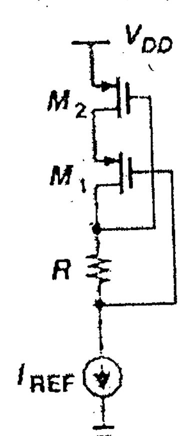

Fig. for Q. No. 2(c)

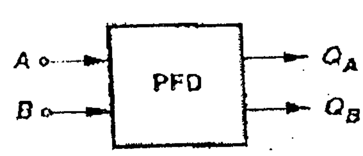

Fig. for Q. No. 4(a)

L-3/T-2/EEE **Date : 26/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

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**.

1. (a) Derive an expression for the inductance of three phase lines with unsymmetrical spacing. **(14)**

   (b) Derive an expression for the inductance of three phase lines with equilateral spacing. **(8)**

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

2. (a) Derive an expression for the capacitance of three phase transmission lines considering the effect of earth. **(13)**

   (b) A three-phase 50-Hz transmission line has its conductors arranged in a triangular formation so that two of the distances between conductors are 25 ft and the third is 42 ft. The conductors are ACSR Osprey. Determine the capacitance to neutral in microfarads per mile and the capacitive reactance to neutral in ohm-miles. If the line is 150 mile long, find the capacitance to neutral and capacitive reactance of the line. Consider GMR = 0.0284 ft and the outside diameter of the conductor as 0.879 in. **(12)**

   (c) Calculate the capacitive reactance in ohm-kilometers of a bundled 50-Hz three phase line having three ACSR Rail conductors per bundle with 45 cm between conductors of the bundle. The spacing between bundle centers is 9, 9 and 18 m. Consider the outside diameter of the conductor as 1.165 inch. **(10)**

3. (a) Derive an expression for the magnetic flux linkage of one conductor in a group. **(10)**

   (b) Derive an expression for the capacitance of a three phase line with unsymmetrical spacing. **(13)**

   (c) Six conductors of ACSR Partridge constitute a 50-Hz double circuit three phase line arranged as shown in Fig. for Q. No. 3(c). Find–

   (i) The inductance per phase (in H/mi) and the inductive reactance (in Ω/mi).

Contd P/2

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Contd... Q. No. 3(c)

(ii) The capacitive reactance to neutral (in Ω.mi) and the charging current in A/mi per phase and per conductor at 132 kV. Consider GMR - 0.0217 ft and the outside diameter of the conductor as 0.642 in.

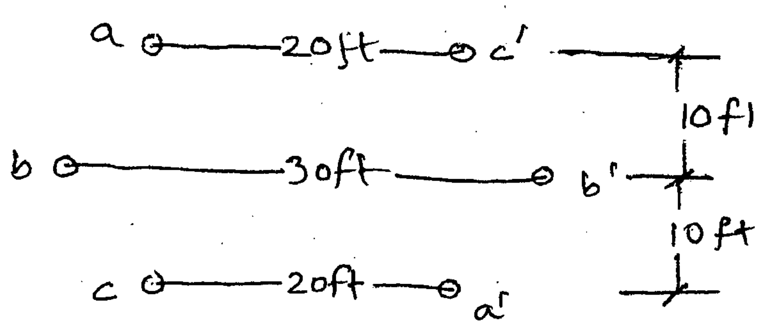

Fig. for Q. No. 3(c)

4. (a) A 250-kcmil, single conductor, synthetic rubber, belted cable has a conductor diameter of 0.575 in and inside diameter of sheath of 1.235 in. The cable has a length of 6000 ft and is going to be used at 50 Hz and 132 kV. Calculate the following: **(11)**

   (i) Total insulation resistance in MΩ.

   (ii) Power loss due to leakage current flowing through insulation resistance.

   The insulation resistance of synthetic rubber is 2000 MΩ/1000 ft.

   (b) Assume that a three-conductor belted cable 4 mi long is used as a three-phase underground feeder and connected to a 11-kV, 50 Hz substation bus. The load at the receiving end, draws 40 A at 0.85 lagging power factor. The capacitance between any two conductors connecting the third conductor to the sheath is measured to be 0.45 μF/mi. Ignoring the power loss due to leakage current and also the line voltage drop, calculate the following: **(14)**

   (i) charging current of feeder

   (ii) sending-end current

   (iii) sending-end power factor.

   (c) Explain how location of fault in an underground cable is determined by using Varley loop test. **(10)**

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SECTION – B

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

5. (a) Consider the single line diagram shown in Fig. for Q. No. 5(a). All impedances are in per unit. **(12)**

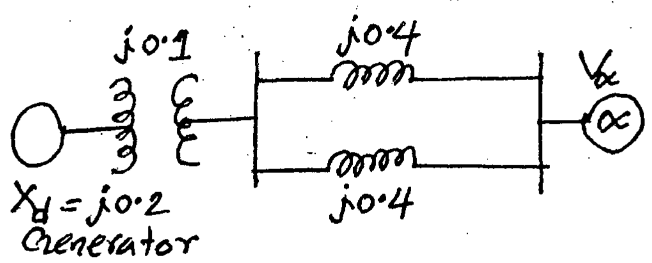

Fig. for Q. 5(a)

NO.

The machine is delivering 1.0 p.u. power and both the terminal voltage and the infinite bus voltage are 1.0 p.u. Determine (i) the power angle equation of the system, (ii) swing equation if p = 0.9 p.u.

(b) The power angle equations of a generator are: **(12)**

Before the fault: $P_e = P_{max} \sin \delta$

During the fault: $P_e = P_1 \sin \delta$

After the fault : $P_e = P_2 \sin \delta$

Determine the critical clearing angle for the fault.

(c) What is the effect of increasing transient reactance of a generator on stability? Explain. **(11)**

6. (a) Show the typical circuit arrangement of high voltage DC transmission for **(10)**
   (i) monopolar arrangement and
   (ii) bipolar arrangement.

(b) The total power transmission capability of a bipolar DC system and a 3-phase 3-wire AC system are same. The two systems have same thermal limit, crest voltage, length and conductor size. Determine the power factor of the AC system. **(15)**

(c) Write the major advantages and disadvantages of DC transmission over AC transmission. **(10)**

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7. (a) Describe the principles of series capacitor compensation with necessary figures and vector diagrams. **(10)**

(b) Draw the VAR compensation topology implemented with a voltage source converter in STATCOM. Draw the associated vector diagrams in leading and lagging power factor. **(15)**

(c) Draw the topology of unified power flow controller (UPFC). Describe its main features. **(10)**

8. (a) Describe briefly the solution techniques for reducing harmonic in the design stage and for existing facilities. **(10)**

(b) Explain what happens to allowable percentage of individual harmonics and total demand distortion (TDD) if I_{SC}/I_L at PCC is increased and why? **(8)**

(c) Determine the magnitude of voltage sag if the fault is at 33 kV and the PCC is at 132 kV. Use the following table. **(8)**

Voltage level	Fault level
400 V	20 MVA
11 kV	200 MVA
33 kV	900 MVA
132 kV	3000 MVA
400 kV	17,000 MVA

(d) Derive an equation to obtain the critical distance at which a fault will lead to a sag of certain magnitude. **(9)**

(i)

L-3/T-2/EEE **Date : 02/06/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

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**.

1. (a) Describe four basic management functions that managers perform in an organization. **(12)**

(b) Discuss 'Matrix'-type organizational structure along with it's advantages and disadvantages. Also give an example of a matrix-type organization and explain why it is matrix type. **(12)**

(c) Consider a worker, who is working in a shoe factory, has to produce 360 pieces. The standard task is 80 pieces, where the low task is 75% of the standard task. If the wage rate is $30 per hour and the worker takes 4 hrs to complete the job, then calculate his earning per hour, under Rowan Plan. **(11)**

2. (a) Describe different organization design approaches. **(13)**

(b) Discuss five sources of 'Power' with necessary examples. **(10)**

(c) Discuss and describe the steps of delegation of power. **(12)**

3. (a) Discuss Hemner's rules for behavioral modification. **(13)**

(b) Describe different stages of team development. **(10)**

(c) If you want to withdraw the following amounts over next five years from a savings account that earns 7% interest compounded annually, how much do you need to deposit now? **(12)**

Year	Amount
2	$2000
3	$3000
4	$6000
5	$8000

4. (a) Voltar Company manufactures and sells a telephone answering machine. The company's contribution format income statement for the most recent year is as follows: **(23)**

Contd P/2

IPE 493/EEE

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

	Total	Per Unit	Percent of Sales
Sales (20,000 units)............	$1,200,000	$60	100%
Less variable expenses..........	900,000	45	? %
Contribution margin.............	300,000	$15	? %
Less fixed expenses............	240,000		
Net operating income............	$ 60,000		

Management is anxious to improve the company's profit performance and has asked for an analysis of a number of items.

(i) Compute company's CM ratio and variable expense ratio.

(ii) Compute company's break even point in both units and sales dollars.

(iii) Assume that sales increases by $400,000 next year. If cost behavior patterns remain unchanged, then by how much will the company's net operating income increase? Use the CM ratio to determine your answer.

(iv) Refer to the original data. Suppose management want to sell high quality speaker. The higher quality causes an increase in variable cost by $3 per unit. Manager has also eliminated one quality inspector who was paid $30,000 per year. If he assumes it will increase the annual sale by 4000 units, then determine whether he should make these changes.

(b) Memofax, Inc., produces memory enhancement kits for fax machines. Sales have been very erratic, with some months showing a profit and some months showing a loss. The company's income statement for the most recent month is given below: **(12)**

Sales (13,500 units at $20 per unit)	$270,000
Less variable expenses	189,000
Contribution margin....................	81,000
Less fixed expenses....................	90,000
Net operating loss.....................	$ (9,000)

(i) Compute CM ratio and break even point in both units and dollars.

(ii) The sales manager feels that an $8,000 increase in the monthly advertising budget, combined with intense effort by sales staff, will result in a $70,000 increase in monthly sales. How this change will affect the monthly net operating income or loss?

Contd P/3

IPE 493/EEE

SECTION – B

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

5. (a) Do you agree that EOQ model is a robust model? Justify your answer by providing mathematical proof. **(10)**

(b) Briefly explain the "Power of two" policy. **(10)**

(c) An item sells for $25 a unit, but a 10% discount is offered for lots of 150 units or more. A company uses this item at the rate of 20 units per day. Setup cost is $50 and holding cost per unit per day is $0.30. The lead time is 12 days. Determine the optimal inventory policy. **(15)**

6. (a) Briefly discuss the term "System nervousness" in MRP. State and explain the ways of overcoming this problem. **(10)**

(b) An end item A has a planned lead time of two weeks. There are currently 120 units on hand and no scheduled receipts. Setup cost is $400 and holding cost $2 per unit per week. Master production schedule for the next 10 weeks is given below. **(17)**

Week :	1	2	3	4	5	6	7	8	9	10
Demand:	41	44	84	42	84	86	7	18	49	30

Now compute the planned order releases and total cost using

(i) 'EOQ'

(ii) 'PPB' policy

(c) Briefly discuss different types of production systems with suitable examples. **(8)**

7. (a) A manager is trying to determine which forecasting method to use. He gathered the following historical data **(25)**

Month	Actual demand
1	62
2	65
3	67
4	68
5	71
6	73

Based on above data, please calculate the following:

(i) Single exponential smoothing forecast for periods 2-6 using an initial forecast of 61 and an α of 0.30

(ii) Exponential smoothing with trend adjustment forecast for periods 2-6 using initial trend forecast of 1.8, an initial exponential smoothing forecast of 60, an α of 0.30 and β of 0.30

(iii) Calculate MAD for the forecast made by above (i) and (ii) technique in periods 4-6. Which forecasting method do you prefer and why?

(b) Discuss about different demand options in aggregate planning. **(10)**

Contd P/4

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8. (a) Suppose you have the alternative of receiving either $10,000 at the end of five years or 'P' dollars today. Currently, you have no need for the money, so you deposit the 'P' dollars into a bank account that pays 6% compound interest annually. What value of 'P' would make you indifferent in your choice between 'P' dollars today and promise of $10,000 at the end of five years? **(3)**

(b) How would you conduct a marketing research? **(12)**

(c) For the information shown below:

(i) prepare a schedule of cost of goods manufactured. **(7)**

(ii) compute the cost of goods sold **(6)**

(iii) prepare an Income statement. **(7)**

The following information has been taken from the accounting records of Klear-Seal Company for five years:

Selling expenses	$ 140,000
Raw materials inventory, January 1	90,000
Raw materials inventory, December 31	60,000
Utilities, factory	36,000
Direct labor cost	150,000
Depreciation, factory	162,000
Purchases of raw materials	750,000
Sales	2,500,000
Insurance, factory	40,000
Supplies, factory	15,000
Administrative expenses	270,000
Indirect labor	300,000
Maintenance, factory	87,000
Work in process inventory, January 1	180,000
Work in process inventory, December 31	100,000
Finished goods inventory, January 1	260,000
Finished goods inventory, December 31	210,000

L-3/T-2/EEE **Date : 12/05/2014**

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-3/T-2 B. Sc. Engineering Examinations 2011-2012

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**.

1\. (a) A continuous time signal $x_c(t) = \cos(2\pi F_1 t) + \cos(2\pi F_2 t)$ is sampled at F_s samples/sec and resulting discrete-time signal is $x[n] = A\cos(2\pi f n)$. Find the value of F_s that will provide f corresponding to F_1 and in this case also find the value of A. Consider $F_1 = 2000$ Hz and $F_2 = 8000$ Hz. **(10)**

(b) Consider the discrete-time system as shown in Fig. for Q. No. 1(b). **(10)**

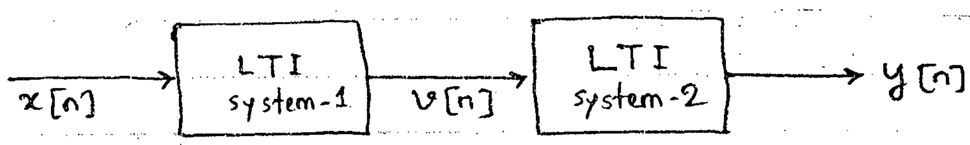

Fig. for Q. No. 1(b)

The first system is described by

$$H_1(e^{j\omega}) = \begin{cases} 1, & |\omega| < 0.5\pi \\ 0, & 0.5\pi \le |\omega| < \pi. \end{cases}$$

The second system is described by $y[n] = v[n] - v[n-2]$. The input to this system is $x[n] = \cos(0.8\pi n) + \delta[n-3] + 5$. Determine the output $y[n]$.

(c) Derive the condition of causality of an LTI system. **(7)**

(d) Determine whether the system $T\{x[n]\} = e^{x[n-3]}$ is (i) causal, (ii) stable, and (iii) LTI. **(8)**

2\. (a) **(12)**

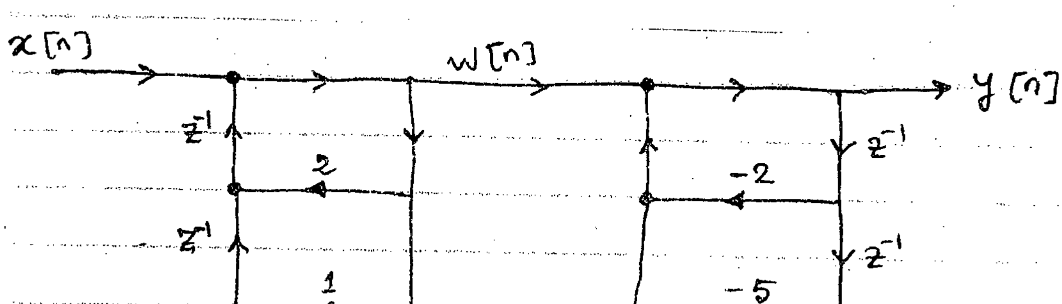

Fig. for Q. No. 2(a)

Contd P/2

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

(i) Find the overall system function $H(z)=\dfrac{Y(z)}{X(z)}$ for the system shown in Fig. for Q. No. 2(a).

(ii) Write the difference equation relating x[n] and y[n] for this system.

(iii) In this realization, how many real multiplications, real additions and storage registers are required to compute each sample of output? (Assume x[n] is real and multiplication by 1 does not count in the total).

(iv) Draw an alternate realization of this system (if any) and comment on its computational complexity with respect to the given realization.

(b) Consider an LTI system with $\left|H(e^{j\omega})\right|=1$ and let arg $\left[H(e^{j\omega})\right]$ be as shown in Fig. for Q. No. 2(b). If the input is $x[n]=\cos\left(\frac{5\pi n}{3}\right)+\cos\left(\frac{\pi n}{3}+\frac{\pi}{3}\right)$, determine the output $y[n]$. **(10)**

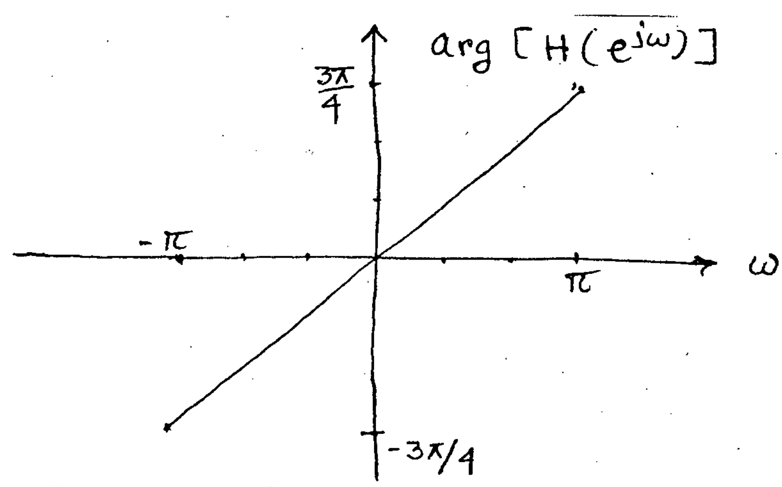

Fig. for Q. No. 2 (b)

(c) **(13)**

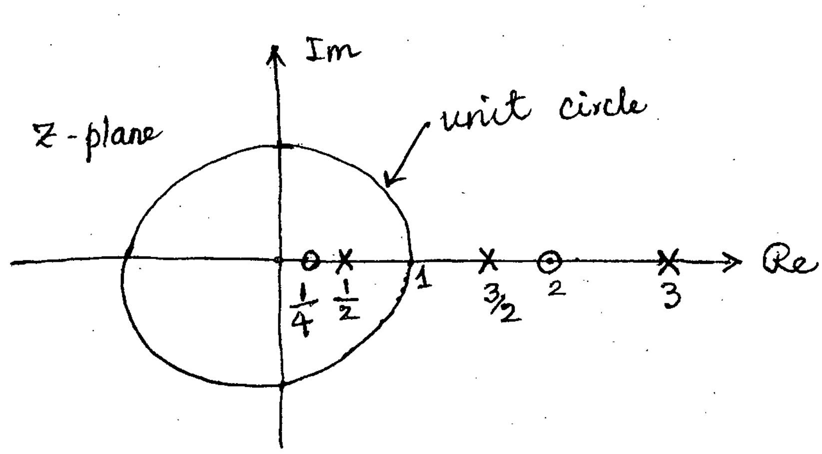

Fig. for Q. No. 2 (c)

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

Consider the Z-transform shown in Fig. for Q. No. 2(c) corresponding to a system function H(z). (i) Mention all possible ROCs, (ii) For each ROC, comment on causality and stability (iii) Write the expression of causal-stable $h[n]$ (if any).

3. (a) Consider the following system (Fig. for Q. No. 3(a)) **(18)**

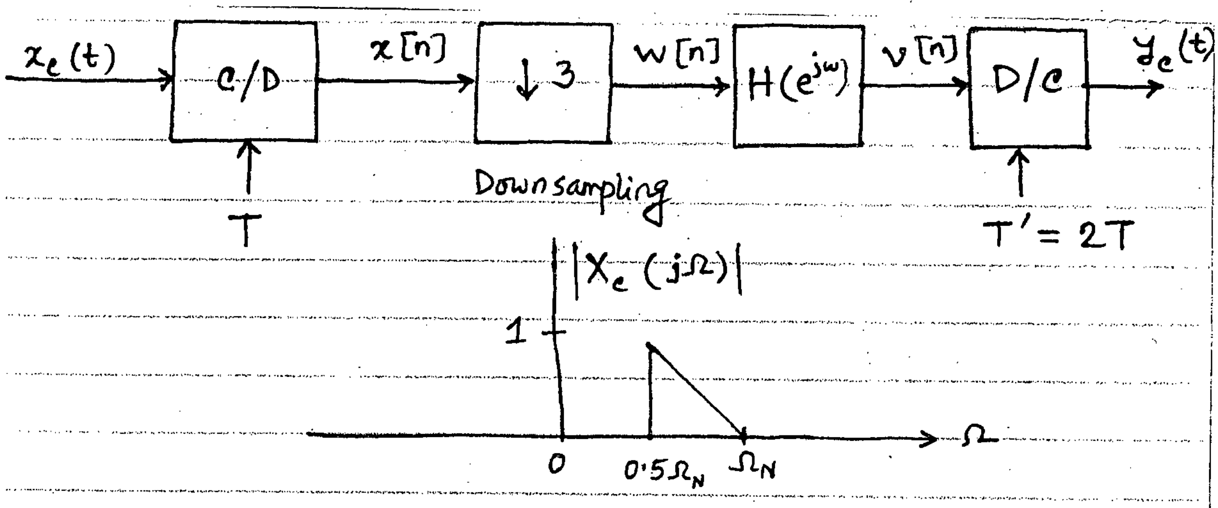

Fig. for Q. No. 3(a)

In the above system, $H(e^{j\omega}) = \begin{cases} 1, & |\omega| < 2\pi/3 \\ 0, & \frac{2\pi}{3} < |\omega| \leq \pi \end{cases}$

and $|X_c(j\Omega)|$ is shown in the figure. Given that the original sampling rate Ω_s (corresponding to T in the figure) is three times of Ω_N (i.e. $\Omega_s = 3\Omega_N$). Sketch (i) $|X(e^{j\omega})|$, (ii) $|W(e^{j\omega})|$, (iii) $|V(e^{j\omega})|$, and (iv) $Y_c(j\Omega)$

(b) When the input to an LTI system is **(17)**

$$x[n] = \left(\frac{1}{3}\right)^n u[n] + 2^n u[-n-1]$$

the corresponding output is

$$y[n] = 5\left(\frac{1}{3}\right)^n u[n] - 5\left(\frac{2}{3}\right)^n u[n]$$

Using Z-transform method, find the impulse response $h[n]$ of the system and determine whether or not the system is stable and/or causal.

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4. (a) Draw the signal flow graph for a causal FIR system with impulse response **(10)**

$$h[n]=\{\underset{\uparrow}{2}\ \ 1\ \ -2\ \ 5\ \ -2\ \ 1\ \ 2\}$$

Note that your design must ensure minimum number of multiplier.

(b) In a decimator system what type of filter is generally used and why? With a simplified block diagram explain the process of changing the sampling rate of a signal $x[n]$ from F_S to 0.8 F_S. **(10)**

(c) Find the step response of an initially-relaxed causal LTI system described by following difference equation using time-domain technique **(15)**

$$y[n]=5y[n-1]-6y[n-2]+2x[n-1].$$

SECTION – B

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

5. (a) The transfer function H(z) of a causal LTI system has the pole-zero configuration shown in Fig. for Q. 5(a). It is also known that H(z) = 6 when z = 1. **(12)**

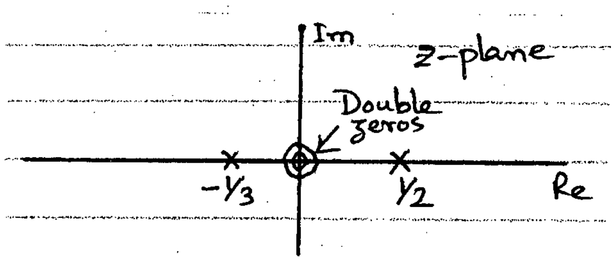

Fig. for Q. 5(a).

Determine the response of the system to the input signal x(n), obtained from sampling the continuous signal

$$x(t)=50+10\cos(20\pi t)+30\cos(40\pi t)$$

at a sampling frequency F_S = 40 Hz.

(b) Consider a causal sequence x(n) with the z-transform **(11)**

$$X(z)=\frac{\left(1-\frac{1}{2}z^{-1}\right)\left(1-\frac{1}{4}z^{-1}\right)\left(1-\frac{1}{5}z\right)}{\left(1-\frac{1}{6}z\right)}$$

Find the values of α so that $\alpha^n x(n)$ be a real, minimum-phase sequence.

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Contd... Q. No. 5

(c) Suppose that a stable nonminimum-phase LTI system, H(z) is cascaded with a compensating system $H_c(z)$ as shown in Fig. for Q. 5(c). **(12)**

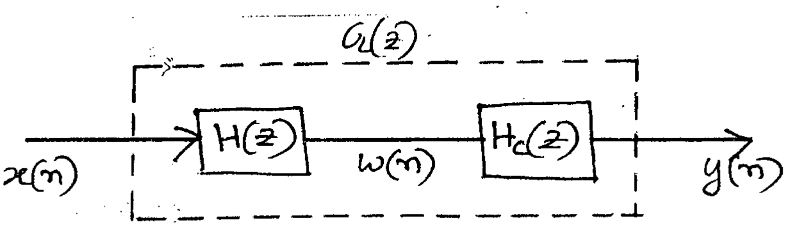

Fig. for Q. 5(c)

(i) How should $H_c(z)$ be chosen so that it is stable and causal, and the magnitude of the overall effective frequency response is unity?

(ii) Assume that

$$H(z)=\left(1-0.8e^{j0.3\pi}z^{-1}\right)\left(1-0.8e^{-j0.3\pi}z^{-1}\right)\left(1-1.2e^{j0.7\pi}z^{-1}\right)\left(1-1.2e^{-j0.7\pi}z^{-1}\right)$$

Find $H_c(z)$ and G(z) for this case.

6. (a) Fig. for Q. 6(a) shows a sequence x(n) for which the value of x(3) is an unknown constant c. Let **(11)**

$$X_1(k)=X(k)e^{j2\pi 3k/5},$$

where X(k) is the five-point, DFT of x(n). The sequence $x_1(n)$ plotted in Fig. for Q. 6(a) is the inverse DFT of $X_1(k)$. What is the value of c?

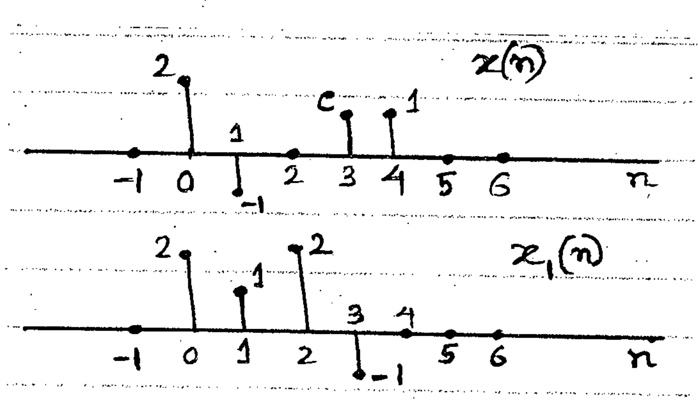

Fig. for Q. 6(a)

(b) Consider the finite-length sequence **(13)**

$$x(n)=2\delta(n)+\delta(n-1)+\delta(n-3).$$

(i) Compute the four-point DFT X(k)

(ii) Compute the four-point inverse DFT of $Y(k)=X^2(k)$ to obtain a sequence y(n) for n = 0, 1, 2, 3.

(iii) If N-point DFTs are used in the previous two steps, how should you choose N so that $y(n)=x(n)*x(n)$ for $0\le n\le N-1$?

Contd P/6

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Contd... Q. No. 6

(c) An input signal x(n) has been distorted by an FIR system with the impulse response **(11)**

$$h(n)=\delta(n)-\frac{1}{2}\delta(n-n_0)$$

where n_0 is a positive integer. We wish to recover the original signal x(n) by processing the distorted output. Suppose that we use an FIR filter of length N in an attempt to implement the inverse filter, and let the N-point DFT of the FIR filter be

$$G(k)=\frac{1}{H(k)},\ k=0, 1, ..., N-1.$$

It might appear that the FIR filter $G(k)=1/H(k)$ implements the inverse filter perfectly. Briefly explain the fallacy in this argument.

7. (a) Derive the necessary conditions for a realizable digital filter to have a linear phase characteristic. Also explain the advantages of filters with such a characteristic. **(12)**

(b) A highpass linear phase FIR filter is characterized by the following impulse response coefficients: **(8)**

$$h(n)=\{0.0575,-0.0544,-0.2955,0.5673,-0.2955,-0.0554,0.0575\}$$

Determine the coefficients of an equivalent lowpass filter.

(c) A linear phase bandpass digital filter is required to meet the following specification: **(15)**

passband	12-16 kHz
transition width	3 kHz
sampling frequency	48 kHz
passband ripple	0.01 dB
stopband attenuation	>50 dB

Assume that the coefficients of the filter are to be calculated using window method. Determine the following issues for the filter:

(i) type of window

(ii) the number of filter coefficients

(iii) the expression of ideal bandpass filter $h_D(n)$ for $-\infty<n<\infty$

(iv) the coefficients of the required bandpass filter $h(n)=h_D(n)\omega(n)$ for $-3\le n\le 3$

(v) the necessary modification for causal implementation of the obtained filter h(n).

Contd P/7

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8. (a) An analog signal is contaminated by a 50 Hz signal and its harmonic at 150 Hz. Assume that the contaminated signal is sampled at 1 kHz. Find the transfer function of a simple digital filter to remove the interference and its harmonic. **(10)**

(b) A requirement exists to simulate, in a digital computer, an analog filter with the following transfer function: **(10)**

$$H(s)=\frac{0.5}{s(s+0.5)}$$

Obtain the transfer function of the digital filter using the impulse invariant method. Assume a sampling frequency of 1 (normalized).

(c) The specification of a certain highpass filter is given below: **(15)**

passband	125-250 Hz
stopband	0–50 Hz
passband ripple	3 dB
stopband attenuation	20 dB
sampling frequency	500 Hz

Assuming that the filter has a Butterworth response, determine the transfer function H(z) of the filter using the bilinear z-transform.
