

SECTION – A

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

Symbols have their usual meanings.

1. (a) Explain how the numerical instability of a recursive least-square (RLS) algorithm can be alleviated. (15)

(b) Electroencephalogram (EEG) signals are obtained by placing electrodes on the scalp. Since the signals are of low amplitude, they are often contaminated by signals arising due to large-valued electrical potentials corresponding to eye and heart. The signals representing the electrical activities of eye and heart are called electroculogram (EOG) and electrocardiogram (ECG) signals, respectively. Derive an adaptive filtering method to remove these unwarranted contaminations. (20)

Assume that reliable estimates of EOG and ECG can be obtained from 4 and 8 sensors placed around the eye and on the chest, respectively. Also comment on your algorithm's real-time applicability.

2. (a) Briefly describe the limitations of a least mean-square (LMS) algorithm and suggest ways to overcome them. (20)

(b) Is it possible to obtain an estimate of the power spectrum density (PSD) of a moving average (MA) process without the knowledge of its parameters — explain. What are the advantages of a least-squares (LS) method over that of Burg for estimating the PSD of an autoregressive (AR) process? (15)

3. (a) Briefly describe the method of Durbin to estimate the PSD of an MA Process. (20)

For an observed discrete-time sequence $x(n)$, which process is more appropriate between the autoregressive (AR) and MA processes, to model the system that generates $x(n)$ and why?

(b) Explain how conventional periodograms can be obtained by using a filter bank. Suggest modifications for the filter bank implementation to obtain the estimates of a Bartlett method. (15)

4. (a) An ARMA (1, 1) process is described by the following difference equation (20)

$$x(n) = \frac{1}{2}x(n-1) + w(n) - w(n-1)$$

Where $w(n)$ is a white noise process with variance σ_w^2 . Find the expression of PSD of $x(n)$ using the values of ARMA parameters. Next, obtain the autocorrelation of $x(n)$ and from it, calculate the PSD of $x(n)$. Compare the results.

- (b) Briefly explain the problem of spectral leakage in the case of deterministic signals. (15)

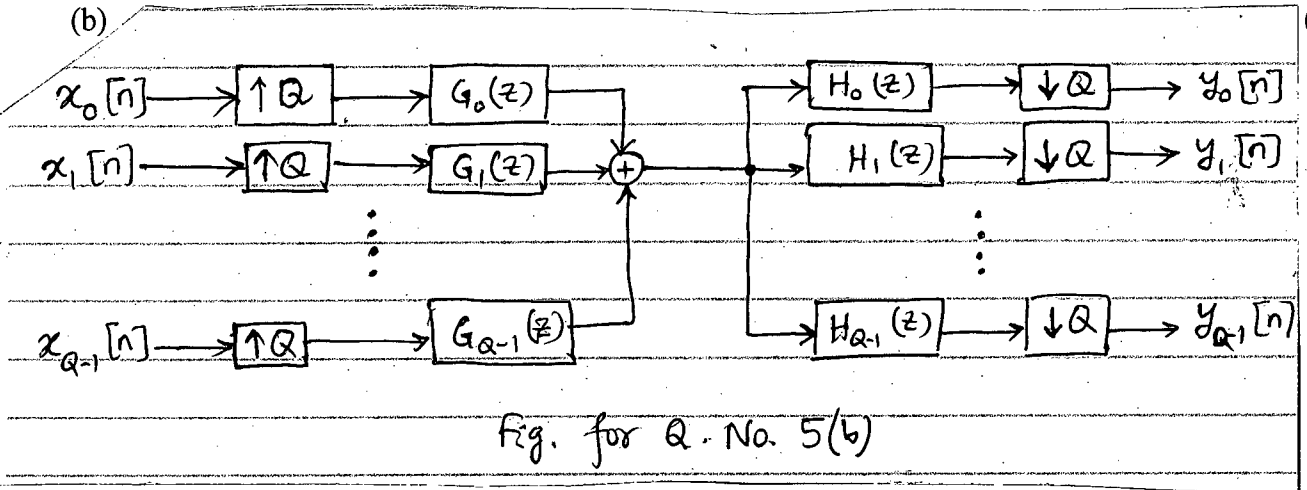
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SECTION - B

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

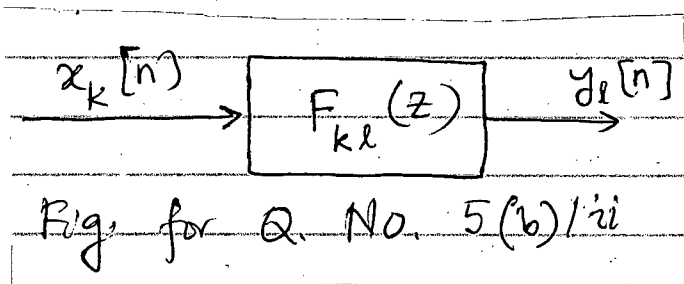
5. (a) Develop a computationally efficient realization of a factor-of-3 interpolator employing a length 9 linear phase symmetric FIR filter. (18)

(b) (17)



Consider the multiinput, multioutput, multirate structure as shown in Fig. for Q. No. 5(b).

- (i) Mention the basic differences between the multirate structure shown in the figure and that of the QMF filter bank.
- (ii) If it is possible to represent the input output relation for one typical path from the k-th input to the l-th output as the following figure,



determine a suitable $\mathbf{F}(z)$ ($Q \times Q$ matrix) which can provide a perfect reconstruction system with

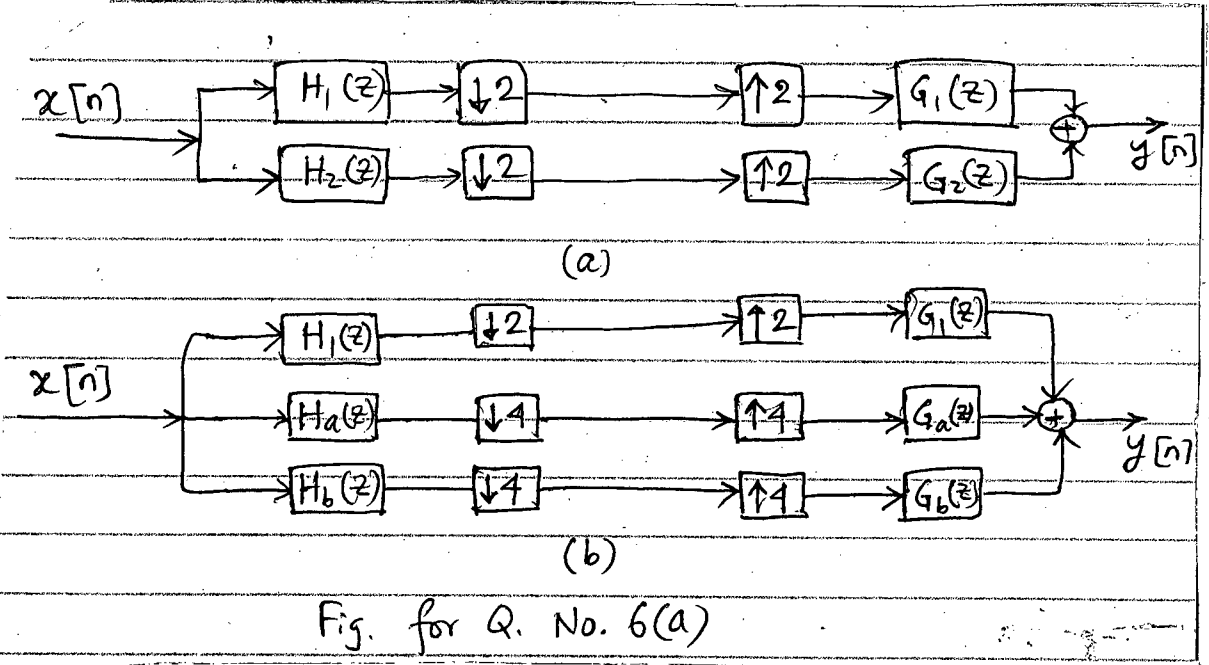
$$y_l[n] = \alpha_l x_l [n - d_l]$$

where d_l is an integer and α_l is a nonzero constant.

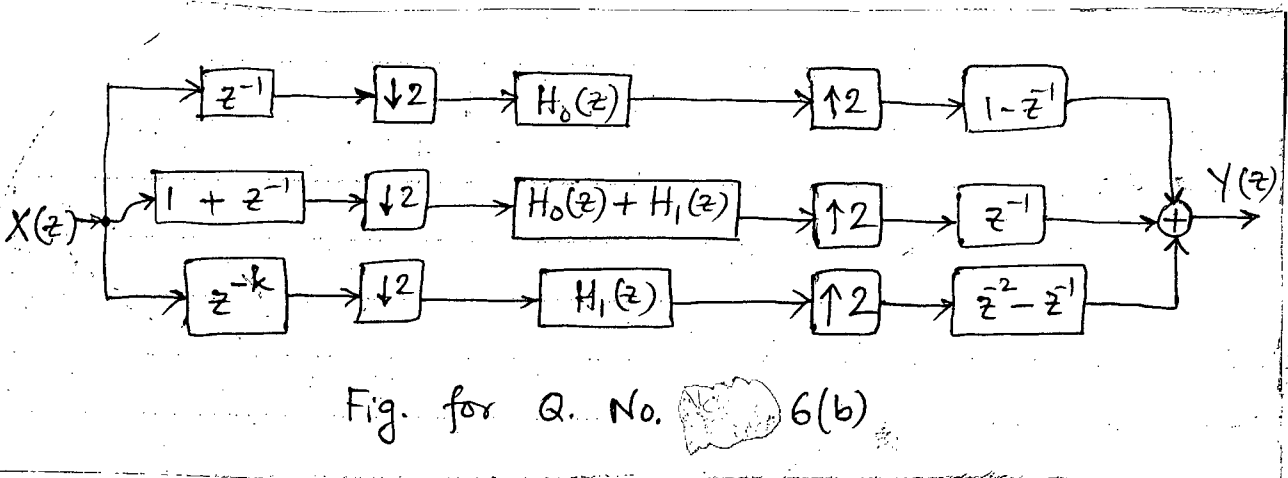
6. (a) Consider the two-channel maximally decimated QMF bank and the equivalent representation of the three-channel filter bank as shown in Fig. for Q. No. 6(a). (15)
- (i) Express $H_a(z)$ and $H_b(z)$ in terms of $H_1(z)$ and $H_2(z)$. Also express $G_a(z)$ and $G_b(z)$ in terms of $G_1(z)$ and $G_2(z)$.
 - (ii) Draw the magnitude frequency responses of $H_1(z)$, $H_a(z)$ and $H_b(z)$.
 - (iii) Mention one common application of such a multi-channel filterbank.

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Contd ... Q. No. 6(a)

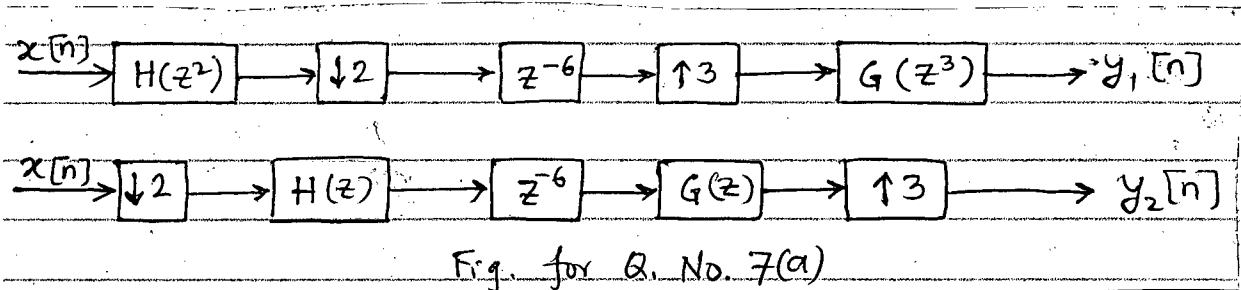


- (b) (i) Find the value of k for which the structure shown in Fig. for Q. No. 6(b) will be alias-free. (20)
- (ii) Under alias-free condition find the overall transfer function $T(z)$.
- (iii) Is it possible to obtain a perfect reconstruction filter with the above structure? Justify your answer.



7. (a) Verify the equivalence of the following two cascade configurations

(10)



(b) What are the advantages of using Wavelet transform in comparison to the short term Fourier transform (STFT) in terms of time and frequency resolution.

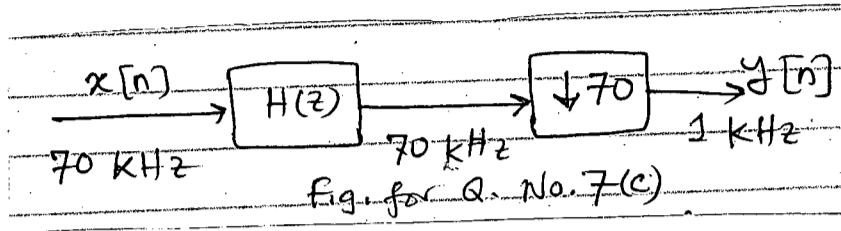
(7)

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Contd ... Q. No. 7

(c)

(18)



Determine the computational complexity of a three stage decimator designed to reduce the sampling rate of a signal from 70 KHz to 1 kHz. The decimation filter is to be designed as an equiripple FIR filter with passband edge $F_p = 350$ Hz, stopband edge $F_s = 250$ Hz, passband ripple $\delta_p = 0.01$, stopband ripple $\delta_s = 0.005$. Filter length N can be obtained as

$$N = \frac{-20 \log \sqrt{\delta_p \delta_s} - 13}{14.6 \times (F_s - F_p) / F_T}$$

where F_T is the sampling frequency

8. (a) Explain with a block diagram how the short term Fourier transform operation can be implemented using bank of band-passfilters along with decimators. What are the two modifications required in the filter bank-decimator module to perform the wavelet operation? (10)

(b) If we define inverse discrete wavelet transform (DWT) as (12)

$$x(t) = \sum_k \sum_n X_{DWT}(k, n) \Psi_{kn}(t)$$

where $X_{DWT}(k, n)$ are the DWT coefficients, find the expression of the basis function $\Psi_{kn}(t)$ and thereby define mother wavelet. In this case, show that $X_{DWT}(k, n)$ can be expressed as

$$X_{DWT}(k, n) = \int_{-\infty}^{\infty} x(t) \Psi_{kn}^*(t) dt$$

(c) Why do we need the scaling function to perform the wavelet transform of a signal? (5)

(d) Describe briefly with a block diagram the method of reducing the effect of noise from the noise-corrupted ECG data using wavelet transform. Consider that the ECG signal is mainly concentrated in the low frequency region and the noise is additive white Gaussian. (8)

The figures in the margin indicate full marks.

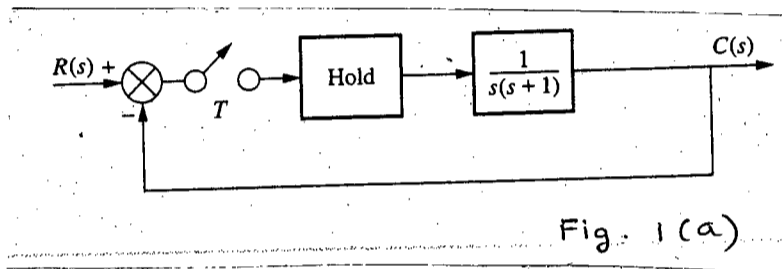
Attach constant M-circles and N-circles (chart) with your Answer Script.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) For the following digital system find the range of sampling interval T to make the system stable. (12)

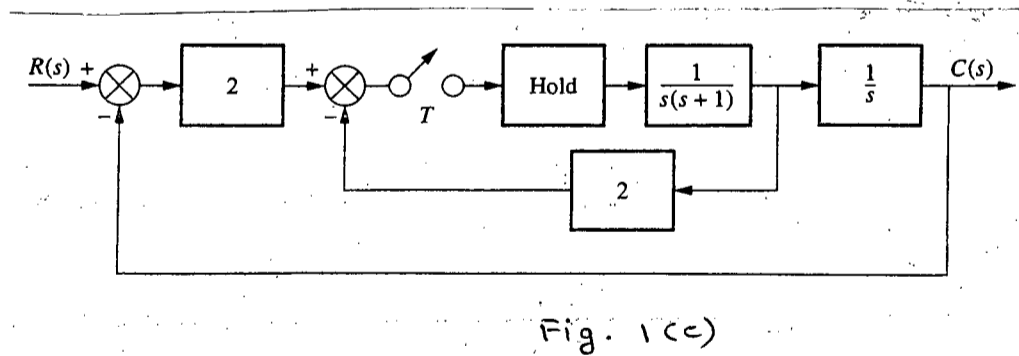


- (b) The space station orientation controller is implemented with a sampler and hold and has the transfer function (12)

$$G(z) = \frac{K(z^2 + 1.1206z - 0.364)}{z^3 - 1.735z^2 + 0.8711z - 0.1353}$$

Determine the value of K that will make the system oscillatory.

- (c) Find the closed loop transfer Function for the system shown in Fig. 1(c) in z-domain. (11)



2. (a) The transfer function of a system is (12)

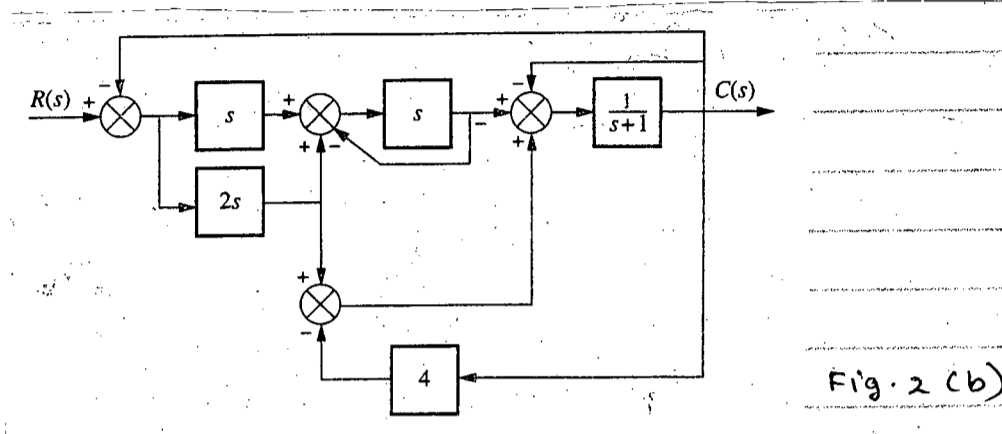
$$T(s) = \frac{s^3 + 2s^2 + 5}{s^4 + 3s^3 + 2s^2 + 4s + 7}$$

Determine the state variable matrix differential equation for the input feedforward format.

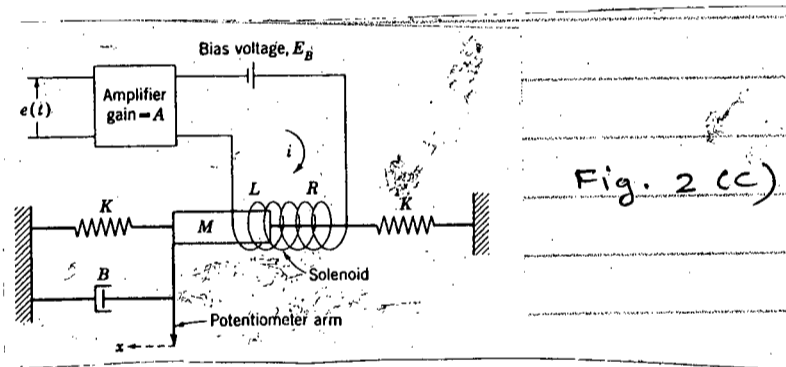
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Contd ... Q. No. 2

(b) For the following system draw the SFG (Signal Flow Graph) and find the overall transfer function using Mason's rule. (12)

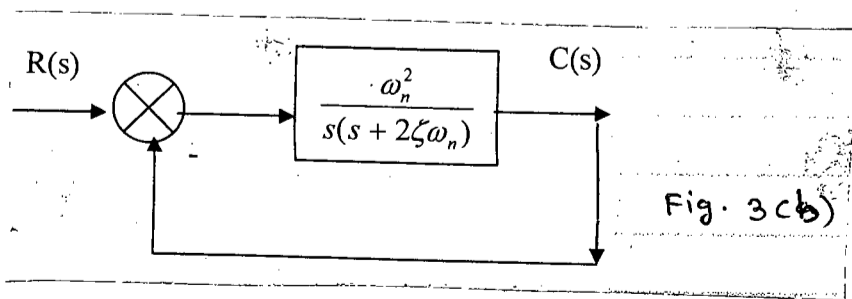


(c) The following figure indicates a possible arrangement for using an error signal to control the movement of a potentiometer arm. The solenoid produces a magnetic force proportional to the current in the coil; that is $f_c = k_c i$, where i is the change of current from the equilibrium condition. (i) Draw a detailed block diagram showing all variables explicitly (ii) Determine the transfer function of each block and (iii) Determine $\frac{X(s)}{E(s)}$. (11)



3. (a) Sketch the root locus for variation in the value of a for a unity negative feedback control system with forward transfer function $G(s) = \frac{10}{(s+2)(s+a)}$. Also determine dominant poles corresponding to 10% overshoot from the root locus. (13)

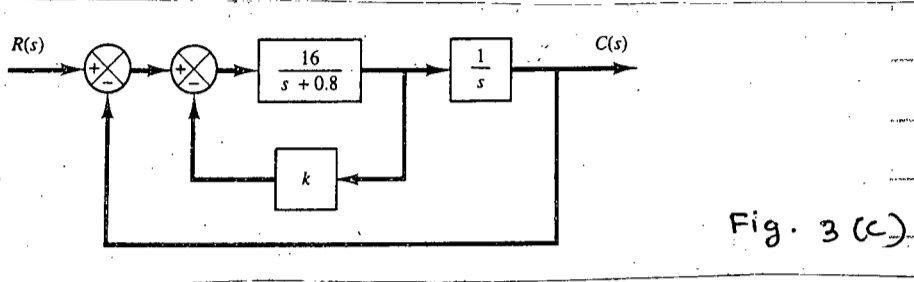
(b) Find the output response of the following control system to a unit impulse input for underdamped case. (10)



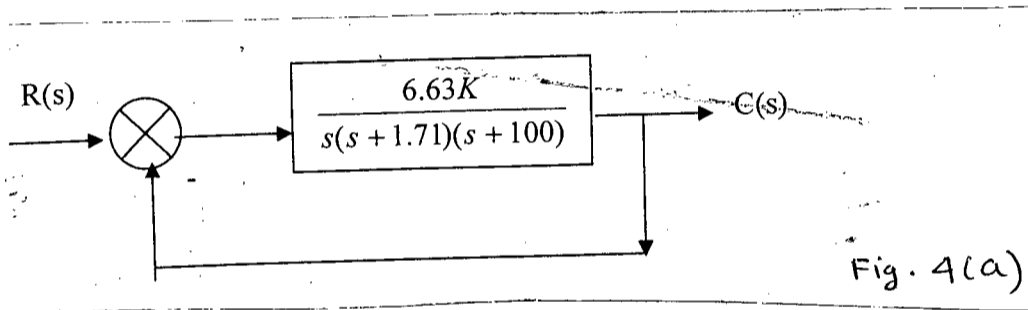
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Contd ... Q. No. 3

(c) For the following system determine the value of k such that the damping ratio ζ is 0.5. Then obtain the rise time t_r , peak time t_p , maximum overshoot M_p and settling time t_s in the unit step response. (12)



4. (a) For the following system design a compensator so that the system can operate with a settling time of 2 second at 25% overshoot and with a zero steady state error for a ramp input. The uncompensated system has the settling time of 4.8 sec. For the uncompensated system the second-order approximation is valid. Also find the gain K and steady state error for the uncompensated system. (25)



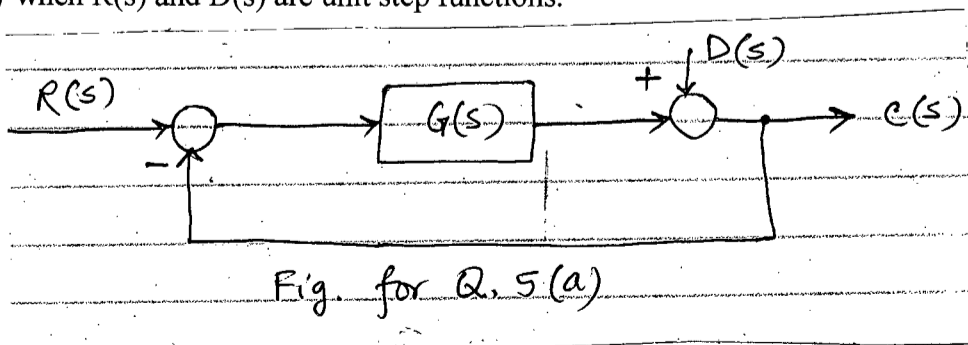
(b) Write the Matlab script to plot the root locus for the system shown in Fig. 4(a) and also to find the dominant roots. (5)

(c) Derive the angle and magnitude condition to sketch the root locus for positive feedback control system. (5)

SECTION – B

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

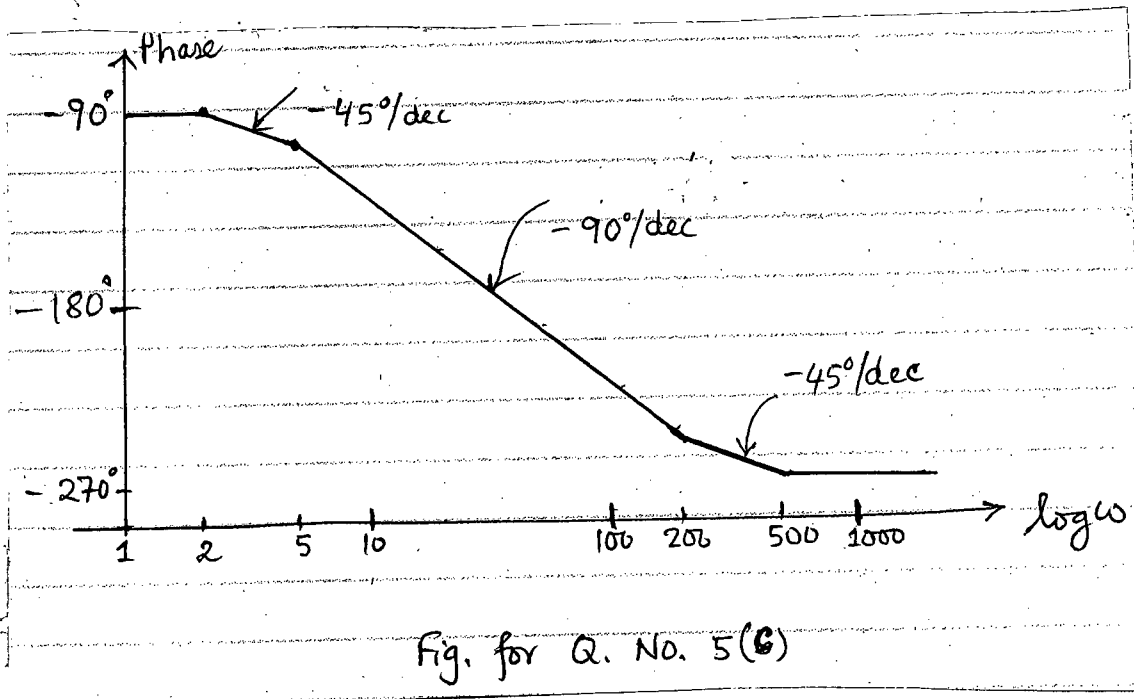
5. (a) For the system shown in Fig. for Q. 5(a) derive the expression for the error $E(s) = R(s) - C(s)$, in terms of $R(s)$ and $D(s)$ and thereby find the steady state error $e(\infty)$ when $R(s)$ and $D(s)$ are unit step functions. (15)



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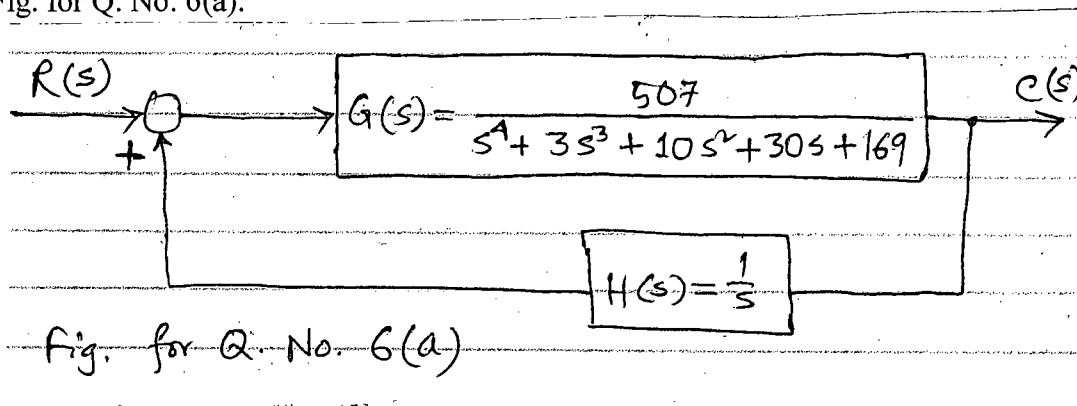
Contd ... Q. No. 5

(b) Briefly explain how to find the static error constants from the Bode magnitude plot. (10)



(c) From the Bode asymptotic phase plot shown in Fig. for Q. No. 5(c) find the transfer function. Consider that at the low frequency region, log magnitude is 20 dB. (10)

6. (a) Using Routh-Hurwitz criterion, find out how many closed-loop poles are located in the right-half or left-half of s-plane or on the jw-axis for the system shown in Fig. for Q. No. 6(a). (17)



(b) State Nyquist stability criterion. For a unity negative feedback control system with open-loop transfer function (18)

$$G(s) = \frac{k(s+1)(s+2)}{(s-3)(s-5)}$$

Sketch the Nyquist diagram and from the diagram using the Nyquist stability criterion find the range of gain k for stability.

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7. (a) Consider a lead network

(10)

$$G(s) = \frac{1}{\beta} \cdot \frac{s + \frac{1}{T}}{s + \frac{1}{\beta T}}, \quad \beta < 1$$

Show that the angular frequency at which the maximum phase angle ϕ_{\max} occurs is

$$\omega_{\max} = \frac{1}{T\sqrt{\beta}}$$

and ϕ_{\max} can be expressed as $\phi_{\max} = \tan^{-1} \frac{1-\beta}{2\sqrt{\beta}}$.

(b) Design a lead compensator of the form as mentioned in Q. No. 7(a) for a unity negative feedback control system with an open-loop transfer function

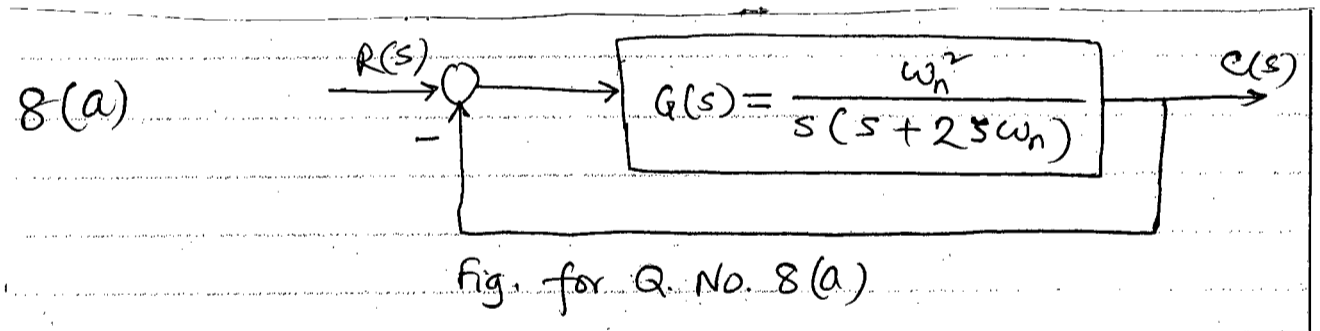
(25)

$$G(s) = \frac{k}{s(s+5)(s+20)}$$

The uncompensated system has about 55% overshoot and a peak time of 0.5 second when $k_v = 10$. Use frequency response method to design the lead compensator with a target to yield a percent overshoot of 10% while keeping the peak time and steady state error about the same or less. Make your required second order approximations.

8. (a)

(15)



Consider the figure shown in Fig. for Q. No. 8(a) and prove

(i) Phase margin $\phi_m = \tan^{-1} \frac{2\zeta}{\sqrt{-2\zeta^2 + \sqrt{1+4\zeta^4}}}$

(ii) Peak value of the closed loop magnitude response $M_p = \frac{1}{2\zeta\sqrt{1-\tau^2}}$

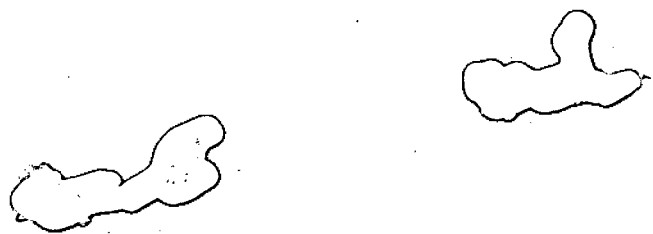
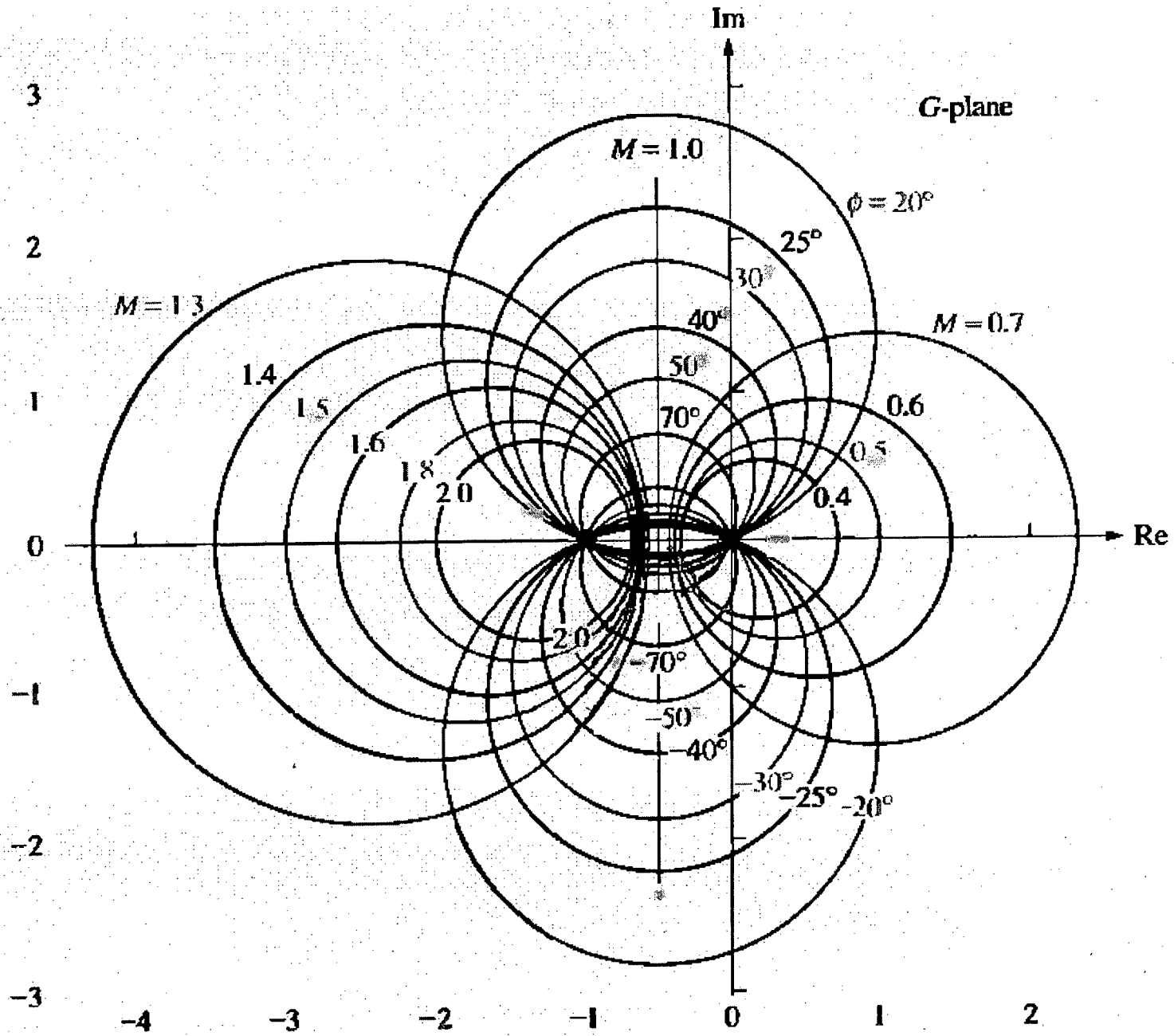
(b) Find the closed loop frequency response of the unity negative feedback control system with open-loop transfer function $G(s) = \frac{50}{s(s+3)(s+6)}$ using the constant

M-circles, constant N-circles and the open-loop polar frequency response curve. In the polar plot indicate the locations corresponding to $\omega = 0.9, 1, 1.5, 2, 3$.

(20)

Please attach the Chart of Constant M-circles & N-circles along with the answer script.

Constant M-Circles and Constant N-Circles



SECTION – A

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

1. (a) What are the differences between soft, firm and hard real time systems? Explain with examples. (9)
- (b) Draw and explain the structure of a real time system. (10)
- (c) What are the advantages of RISC architecture over CISC architecture? (6)
- (d) Name some traditional performance measures. Why are these measures not suitable for evaluating the performances of real time systems? (10)

2. (a) Calculate the performability for the operation of driving a car from a place to another. Time constraints will be neglected. The ultimate result may be one of the following: (17)
 - (i) Not hitting anything and reaching the destination.
 - (ii) Hitting something but reaching the destination.
 - (iii) Being hit by some other vehicle but reaching the destination.
 - (iv) Not reaching the destination.
- (b) Briefly explain: (i) Major Minor Cycles (ii) Foreground/Background Systems. (8)
- (c) What are the differences between processes and threads? Discuss thread models. (4+6=10)

3. (a) Explain the particle swarm optimization algorithm in brief. (12)
- (b) Explain with example why strict alternation is not suitable for Interprocess Communication. Write down and explain Peterson's solution for IPC. (15)
- (c) How can a mutex be implemented by TSL instruction? How does it differ from the implementation of common TSL based lock for mutual exclusion? (8)

4. (a) What are the advantages and disadvantages of Warnier-Orr notation? (8)
- (b) A sequential circuit has two inputs ω_1 and ω_2 and an output z . Its function is to compare the input sequences of the two inputs. If $\omega_1 = \omega_2$ during any four consecutive clock cycles, the circuit produces $z = 1$; otherwise, $z = 0$. For example (27)

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

ω_1	:	0	1	1	0	1	1	1	0	0	0	1	1	0
ω_2	:	1	1	1	0	1	0	1	0	0	0	1	1	1
z	:	0	0	0	0	1	0	0	0	0	1	1	1	0

Derive the state diagram for an FSA. Construct the state assignment table and draw a suitable circuit that realizes the FSA using D flip-flops.

SECTION – B

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

- 5. (a) Write source code in any programming language (preferably C) to implement a ring buffer data structure, using `start_ptr` and `stop_ptr` pointers. Keep provision of distinguishing empty buffer and full buffer and implement enqueue, deque operations. (15)
(b) Discuss necessary conditions for deadlock. Describe the Banker's algorithm with example and explain how it can be used to avoid deadlock. (20)

- 6. (a) Write a real time operating system? Give four reasons why Microsoft Windows 7 should not be considered as a real time Operating system. (15)
(b) Using compiler optimization techniques Minimize the code fragments. Mention the name of the techniques that have been employed by you. (20)
 - a.

```
for (j = 0; j <= 30; j++) {  
    for (k = 0; k <= 30; k++)  
        x[j][k] = y[j][k] + z[j][k];  
}
```
 - b.

```
function fact (int n) {  
    if (n==1) return n;  
    else return n*fact (n-1);  
}
```

- 7. (a) Consider the following set of four tasks: (15)

Task	Execution Time	Period
T ₁	1	8
T ₂	2	5
T ₃	2	10

Comment if T₁, T₂ T₃ are RM schedulable. Comment on their RM schedulability if the execution time for each task is doubled.

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Contd ... Q. No. 7

(b) Describe different CPU scheduling algorithms and what are the criteria to choose one scheduling algorithm over another? Define waiting time, turn around time and throughput. (20)

8. (a) Consider the following code sample: (15)

```
Load A, #40      ; load 40 in A
Move B, A        ; copy A in B
ADD B, #20       ; add 20 to B
STORE 0x573, B   ; store B into RAM
```

Explain how this code segment will be executed with and without instruction pipelining.

(b) Consider the following system which is scheduled by Round Robin Algorithm. (20)

Process	CPU Time (ms)	Arrival Time (ms)
P1	3	0
P2	2	2
P3	9	6
P4	10	9
P5	1	1
P6	6	4

Calculate the average turn-around time considering

- (i) time quanta = 4 ms
- (ii) time quanta = 20 ms

Comment on the turn-around time obtained from these different time quanta.

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-2 B. Sc. Engineering Examinations 2009-2010

Sub : **EEE 475** (Power Plant Engineering)

Full Marks : 210

Time : 3 Hours

The questions are of equal value.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – A

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

1. (a) Discuss the advantages and disadvantages of hydro-electric power plants.
(b) What factors are to be considered for selecting suitable site for hydro-electric power plants?
(c) Draw the schematic layout of a storage type hydro-electric power plant and explain its working principle.
2. (a) Compare among thermal, mechanical, electrical and overall efficiencies of a steam power plant. Write the typical values for each of these efficiencies achieved in practice.
(b) Write down the factors to be considered while selecting a site for a steam power station.
(c) Describe with the help of a general layout the working principle of a steam power plant.
3. (a) What are the various factors to be considered for the selection of the location of a nuclear power plant?
(b) Explain with a neat sketch the working principle of a nuclear power station.
(c) What is fission? Show the major components of a nuclear reactor.
4. (a) Discuss the advantages of IC engine based power generation.
(b) Draw a general layout of an IC Engine based power plant showing essential circuits.
(c) Why lubrication, cooling and ventilation are important for an IC Engine based power station?

SECTION – B

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

5. (a) Define the term demand factor, group diversity factor, load factor and capacity factor.
"The load factor measures the variation only and does not give any indication of the precise shape of the load" – explain.

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Contd ... Q. No. 5

(b) A residential consumer has 10 lamps of 40 watts each connected at his residence. His demands are as follows:

From 12 midnight to 5 AM	:	40 W
From 5 AM to 6 PM	:	No load
From 6 PM to 7 PM	:	320 W
From 7 PM to 9 PM	:	360 W
From 9 PM to 12 midnight	:	160 W

Find the average load, maximum load, load factor and energy consumed during the day.

6. (a) Discuss the factors to be considered in deciding the price per unit of electricity energy. Name the different energy rates commonly followed and draw cost per kilowatt-hour curves for each of them.

(b) A given residential energy rate appears as:

- (i) First 15 KWhr per month or less at Tk. 20.00
- (ii) Next 50 KWhr per month at Tk. 1.50 per KWhr
- (iii) Next 100 KWhr per month at Tk. 2.00 per KWhr
- (iv) Next 150 KWhr per month at Tk. 3.00 per KWhr
- (v) Above 300 KWhr per month at Tk. 4.00 per KWhr

Calculate monthly bill for consuming (i) 165 KWhr, (ii) 315 KWhr and (iii) 1000 KWhr.

7. (a) Discuss in brief the government policy on small power plant in private sector.

(b) Write a brief description of IPPs in Bangladesh with its advantage and disadvantages.

8. Discuss, in brief, the reasons behind the present power-crisis in Bangladesh and its possible solutions.

SECTION – A

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

1. (a) Discuss the design limitations of BJT and explain how these limitations can be minimized in HBT. (10)
- (b) With the help of energy-band diagram and electric field profile, explain Kirk effect in BJT. How Kirk effect is minimized in HBT? (17)
- (c) Compare abrupt and graded junction HBTs in terms of performance parameters. (08)

2. (a) Draw the structure, energy-band diagram and doping profile of a typical (15)
 - (i) Delta doped (ii) Single quantum well (iii) inverted MOS HEMT.
- (b) What is the advantage of delta doping? (03)
- (c) In a GaAs/AlGaAs normal HEMT, the modulation doping is performed by putting a donor density of $2 \times 10^{18} \text{ cm}^{-3}$ over 100 \AA of AlGaAs. Assume that all donors spill their electrons into the GaAs region. (17)
 - (i) Find the first two eigen energies using Airy function approximation.
 - (ii) If all electrons go into the first subband of the triangular quantum well, calculate the position of the Fermi level at 300 K.

3. (a) Mention how velocity saturation effect at high electric field is accounted in the I-V characteristics of MESFET. (10)
- (b) Compare the performance of a P-n junction with Schottky contact. (7)
- (c) In a W-n Si MESFET, the doping concentration of Si is 10^{18} cm^{-3} . (18)
 - (i) Calculate the tunneling probability of the electrons with energies near the conduction band using triangular potential barrier approximation.
 - (ii) What will be the tunneling probability if doping density is increased to 10^{20} cm^{-3} ?

Give that $\phi_m = 4.55 \text{ eV}$, $\chi_{\text{Si}} = 4.01 \text{ eV}$

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4. (a) What is staggered, straddling and broken gap heterojunction? Give one example of each type. (9)
- (b) What is uniaxial and biaxial strain? Why mobility enhancement occurs in strained Si nMOSFETs? (14)
- (c) Discuss the effect of strain on (i) UTB SOI MOSFET (ii) FinFET (iii) Ge pMOSFET (iv) GaAs nMOSFET. (12)

SECTION – B

Question No. 5 is compulsory. Answer any two questions from question no. 6 to question no. 8. All the necessary data are given in Table 1.

5. Draw band diagram of the device in figure 5 along AA' and BB' directions. Work function of gold is 5.1 eV. (45)
6. (a) How the energy gap of $\text{GaAs}_{1-x}\text{P}_x$ is varied with mole fraction? Sketch the corresponding E-k diagram and discuss its light emission efficiency. (12)
- (b) For a particular application you need light with wave-length of 1300 nm. The available material is GaAs, and InAs. Design a quantum wire with GaAs– $\text{In}_x\text{Ga}_{1-x}\text{As}$ material system such that the wire is perfectly lattice matched with InP substrate and the light emitted from the wire can be used in long haul optical communication at 1300 nm. (18)
7. (a) What is charge neutrality level? Why metals are used in electronic circuits? Explain the effect of interface states on metal-semiconductor junction. (15)
- (b) What is Richardson constant? Assuming that the electrons follow the Maxwell-Boltzmann distribution, derive current-voltage relationship of a Schottky contact. (15)
8. (a) What is effective mass? What are the differences among m^*_{dos} , m^*_{σ} , m^*_l , m^*_t , m^*_{hh} , m^*_{lh} , m^*_{so} ? (10)
- (b) Define amphoteric doping. What is "In-rich" and "Ga-rich" GaAs? (5)
- (c) Calculate the donor and acceptor level energies in GaAs and Si. (15)
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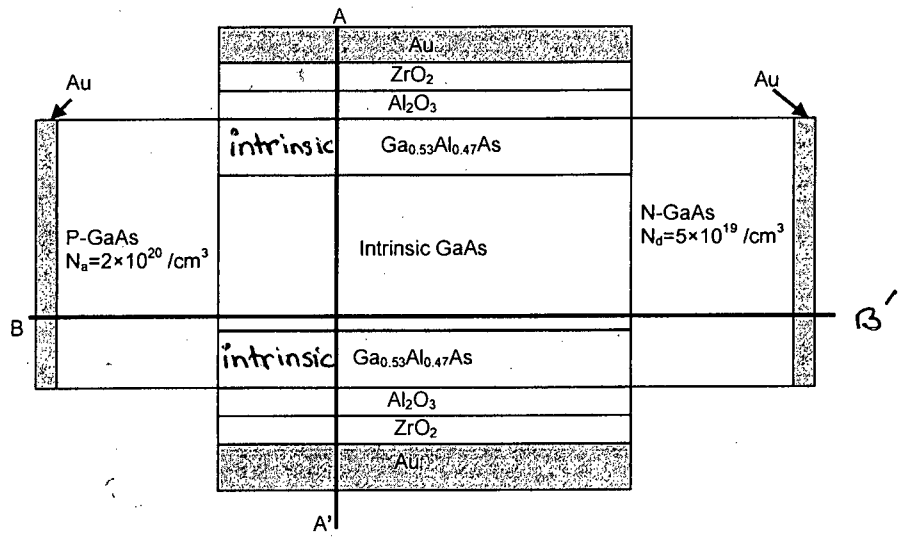


Figure 5

Table 1

Material	a (nm)	E_g (eV)	m_c^*	m_{hh}^*	χ (eV)
GaAs	0.56533	1.42	$m_{dos}^* = 0.067 m_0$	$0.45 m_0$	4.07
AlAs	0.56611	2.229	$m_l^* = 0.97 m_0$, $m_t^* = 0.22 m_0$	$0.76 m_0$	3.5
InAs	0.60584	0.36	$m_{dos}^* = 0.027 m_0$	$0.4 m_0$	4.9
InP	0.58686	1.35	$m_{dos}^* = 0.077 m_0$	$0.64 m_0$	
Si	0.5431	1.12	$m_l^* = 0.98 m_0$, $m_t^* = 0.19 m_0$	$0.49 m_0$	4.01
ZrO ₂		5			2.5
Al ₂ O ₃		9			1.0

SECTION – A

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

1. (a) Classify optical fibers in terms of refractive index, mode and material. Compare SI fibers with GRIN fibers. (10)
- (b) Why cabling is necessary? Draw the typical structure of a multifiber cable with aluminium tape and steel tape. Mention its application. (11)
- (c) Define acceptance angle of a fiber. Estimate the maximum core diameter of a single-mode fiber with a core refractive index of 1.48 and relative refractive index difference of 1%. It is assumed that the fiber is operating at wavelength of 1.55 μm . Further determine the solid acceptance angle in the air for the fiber and critical angle of incidence at the core-cladding interface within the fiber. (14)

2. (a) Find the cut-off condition of a mode in a fiber and hence define the normalized frequency. Show the single mode and multimode condition using necessary illustration. (14)
- (b) Draw the attenuation spectra for different loss mechanisms in silica glass fibers and show the dispersion characteristics of various types of single-mode fibers in the same graph. Write the typical values of dispersion and loss for SSMF, DSF and NZDSF at 1550 nm. (13)
- (c) Explain how differential group delay (DGD) is occurred in an optical fiber. What is polarization-maintaining fiber? (8)

3. (a) What is the physical significance of dispersion parameter? Discuss the elements that cause chromatic dispersion in single-mode fibers with necessary graph. (12)
- (b) With schematic diagram write the functions of different multiport fiber couplers. Explain the operation of an arrayed waveguide grating (AWG) device as a multiplexer or demultiplexer. (15)
- (c) Why fiber connectors are more difficult to achieve than fiber splices? Write the names of different types of fiber splices and connectors. (8)

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4. (a) Write the two basic mechanisms that cause fiber nonlinearities. Why SRS effect is more deleterious than SBS effect for WDM system? (8)
- (b) Compare SPM with XPM. How does FWM affect the multichannel fiber-optic communication system? (13)
- (c) Write short notes on (Any three): (14)
- (i) Optical circulator
 - (ii) Fiber Bragg Grating (FBG)
 - (iii) Linear Scattering effects
 - (iv) Fiber FBT star coupler.

SECTION – B

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

5. (a) Distinguish between spontaneous emission and stimulated emission. Draw the cross-section of a semiconductor laser diode and explain the principle of oscillation in the laser cavity. (12)
- (b) Derive the conditions of oscillation in a laser cavity. Draw the spectrum of a laser diode and state the benefits of using a laser as a light source in optical communication compared to LED. (13)
- (c) What are the different types of LEDs? State their relative merits, limitations and applications. (10)
6. (a) State the relative merits and demerits of using PN, PIN and APD in an optical receiver. (12)
- (b) Draw the cross-section of a APD and explain the mechanism of Avalanche multiplication. What is APD excess noise factor? (13)
- (c) Derive the expression of the signal to noise ratio (SNR) at the output of a PIN receiver and explain the various noise currents. (10)
7. (a) What are the different types of deflection techniques in optical communications? State their principle and relative merits and limitations. (12)
- (b) Draw the block diagram of a optical direct detection receiver and explain the operation briefly. (13)

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(c) An optical receiver is operating at a speed of 560 Mbps using a PIN photo-detector which has a quantum efficiency of 85% at the wavelength of operation of 850 nm. The average optical power input to the photodetector is 250 μ W. The load resistance of the preamplifier is 50 ohm at an operating temperature of 27°C. Determine: (10)

- (i) Responsivity of the Photodiode
- (ii) Shot noise current at the output
- (iii) Thermal noise current at the output
- (iv) SNR at the output.

8. (a) What is an optical amplifier? Mention its merits over a regenerative repeater. Classify optical amplifiers and draw their gain spectrum, comment on their application in optical transmission systems. (12)

(b) Distinguish between the operation of a SLA (SOA) and FPA. Draw the schematic of an EDFA and explain its operational principle. (13)

(c) Write notes on (Any One): (10)

- (i) Dense WDM (DWDM) Transmission System
 - (ii) OFDM distribution system
 - (iii) OTDM.
-

SECTION – A

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

1. (a) With a two transistor model explain the Latching characteristics of a Silicon Controlled Rectifier (SCR). (15)
- (b) What is secondary breakdown? (5)
- (c) Explain why BJT, SCR can not be operated in parallel, whereas MOSFET's can operate in parallel. (10)
- (d) What is the function of the base to emitter resistance added to a high power darlington BJT? (5)

2. (a) For a three phase full-bridge rectifier, show that the dc output voltage is given by (15)

$$V_{dc} = \frac{3\sqrt{3} V_m}{\lambda}$$

where, V_m is the perphase peak voltage considering a sinusoidal supply.
- (b) A three phase full-bridge diode rectifier supplies dc power to a solenoid. The current flow to the solenoid is 30 A dc with negligible ripple. Considering sinusoidal input supply voltage determine (20)
 - (i) input power factor,
 - (ii) average current through each diode,

3. (a) Define total harmonic distortion. (5)
- (b) Draw a single phase ac voltage controller circuit using two back to back SCR's and explain how variable ac (RMS) voltage can be obtained using phase angle control. (15)
- (c) For a single phase ac voltage controller with phase angle control, determine the output RMS voltage as a function of firing angle α . (15)

4. (a) For a three phase full-bridge controlled rectifier derive an expression for the dc output voltage as a function of the firing angle α . (25)
- (b) A three phase dual converter drives a dc motor. The line to line voltage of the ac input supply is 415 V, and supply frequency is 50 Hz. (10)

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

The motor needs 300 V dc across the armature. Determine the firing angle of the forward converter as well as the reverse converter, considering dual mode of operation. **(10)**

SECTION – B

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

All abbreviations and symbols have their usual meaning.

5. (a) With neat sketches explain the operation of the following inverter circuit and draw the input current, input and output voltage waveforms. **(17)**
- (i) Current Source Inverter
 - (ii) Voltage source inverter
- (b) How non overlapping pulses are generated in a full bridge inverter to energize its switches? **(6)**
- (c) For the single phase inverter circuit shown in Fig. 5(c), determine **(12)**
- (i) the rms output voltage at the fundamental frequency.
 - (ii) the output power
 - (iii) the average and peak current of each transistors
 - (iv) the THD
 - (v) the peak reverse blocking voltage of each transistor
6. (a) Explain the advantages of switch mode power supplies compared to linear regulator **(8)**
- (b) Explain the advantage and disadvantages of Buck, Boost and Buck-boost regulators. **(10)**
- (c) Explain the deviation from ideal characteristics of Buck regulator and derive the efficiency equation of the practical Buck converter. Moreover, find the value of duty cycle at which the value of efficiency will be maximum. **(17)**
7. (a) Derive the ideal voltage and current gain characteristics of the following SMPS topologies **(18)**
- (i) Boost converter.
 - (ii) Buck-boost converter.
- (b) A highly inductive load is supplied by a converter as shown in Fig. 7(b). The average load current is 90 A and the load ripple current is negligible. A simple LC filter with $L_e = 0.3 \text{ m H}$ and $C_e = 4500 \text{ } \mu\text{F}$ is used. If the converter is operated at a frequency of 350 Hz and a duty cycle of 0.5, determine the maximum rms value of the fundamental component of converter-generated harmonic current in the supply line. **(12)**
- (c) What are the performance parameter of a converter? **(5)**

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- 8. (a) What are various means for speed control of induction motors? What are the advantage of volts / hertz control? (15)
- (b) What is the principle of phase-locked –loop control of dc drives? (5)
- (c) What is sinusoidal PWM? (5)

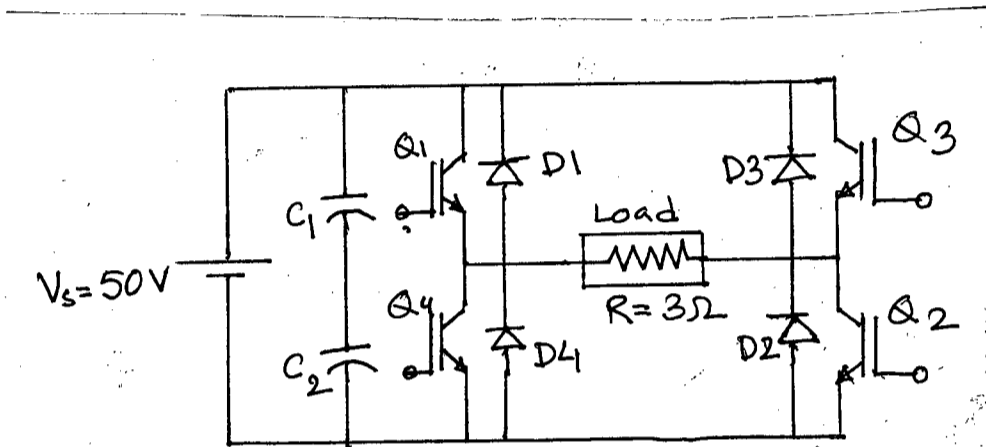


Fig. 5(c)

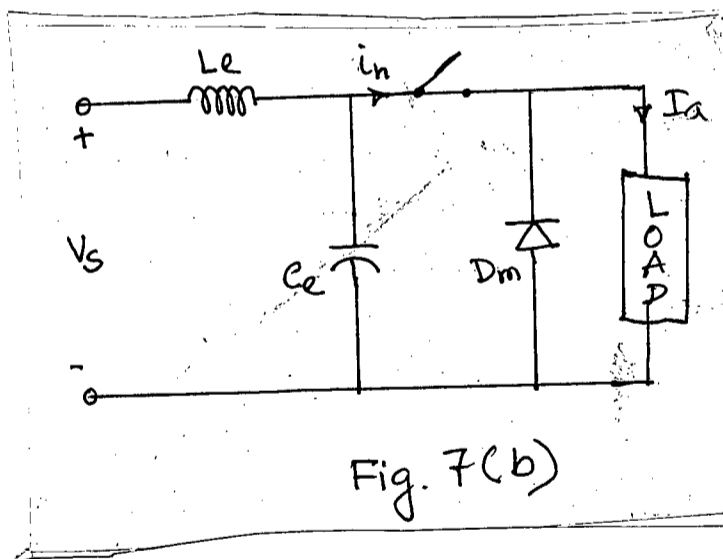


Fig. 7(b)

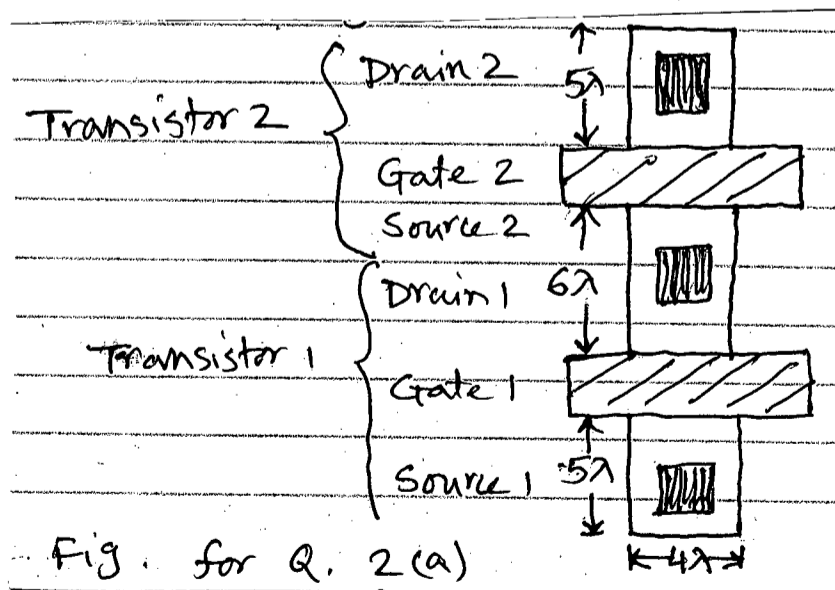
SECTION – A

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

1. (a) In a table show clearly the influence of scaling on L , W , t_{ox} , V_{DD} , V_{th} , N_A and MOS device characteristics β , I_{ds} , R , C , gate delay τ , clock frequency f , dynamic power dissipation per gate P , chip area A , power density and current density. Assume that constant field scaling is adopted. [The symbols have their usual meanings.] (20)

(b) Assume that mobility of electrons is thrice that of holes. Show the schematic diagram at transistor level of a unit inverter driving a similar inverter. Clearly mark the aspect ratio of each transistor. What will be the propagation delay if the input to the first inverter is falling? For this scenario, show the equivalent switch level RC models. Assume that C is the gate capacitance of a unit NMOS transistor. Diffusion capacitance at source or drain of a unit NMOS transistor is also C . The unit NMOS transistor can be assumed to have effective resistance R . (15)

2. (a) For the following figure, calculate the diffusion parasitic capacitance of transistor 1, C_{db1} when the drain is at 0 V and at $V_{DD} = 1.8$ V. Assume the substrate is grounded. The transistor characteristics are $CJ = 0.98$ fF/ μm^2 , $MJ = 0.36$, $CJSW = 0.22$ fF/ μm , $CJSWG = 0.33$ fF/ μm , $MJSW = 0.10$, $MJSWG = 0.12$ and $\psi_0 = 0.75$ V at room temperature. Assume $\lambda = 50$ nm. The symbols have their usual meanings. (18)



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Contd ... Q. No. 2

- (b) Show that fall time of an inverter is given by (17)

$$\tau_f = \frac{2C_L}{\beta_n V_{DD}(1-n)} \left[\frac{n-0.1}{1-n} + \frac{1}{2} \ln(19-20n) \right]$$

$$n = \frac{V_{tn}}{V_{DD}}$$

The symbols have their usual meanings.

3. (a) Show that short circuit dissipation of an inverter is given by, (20)

$$P_{sc} = \frac{\beta}{12} (V_{DD} - 2V_t)^3 \frac{t_{rf}}{t_p}$$

where $V_{tr} = -V_{tp} = V_t$

$t_{rf} = t_r = t_f$

t_p = pulse width

The symbols have their usual meanings.

(b) A digital system in a 1.2 V, 100 nm process has 200 million transistors, of which 25 million are in logic gates and the remainder in memory arrays. The average logic transistor width is 12λ and the average memory transistor width is 4λ . The process has two threshold voltages and two oxide thicknesses. Subthreshold leakage for OFF devices is 25 nA/ μm for low threshold devices and 0.02 nA/ μm for high threshold devices. Gate leakage is 4 nA/ μm for thin oxides and 0.002 nA/ μm for thick oxides. Memories use low leakage devices everywhere. Logic uses low leakage devices in all but 15% of the paths that are most critical for performance. Diode leakage is negligible. Estimate the static power consumption. How would the power consumption change if the low leakage devices were not available? (15)

4. (a) Show the process sequence of fabricating an inverter on a NWELL CMOS process. Clearly show the mask used and the device cross-sectional diagram after each step. (18)

(b) Show in a diagram, the origin and model of CMOS latch up in a NWELL process. How latch up can be prevented? (17)

SECTION - B

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

5. (a) Design an 8-bit carry select adder such that the total propagation delay is minimized. Assume delay of each adder cell is 4 nSec. and propagation delay of the multiplexer is 2 nSec. Derive any equation used in your calculation, and show the schematic diagram of the adder circuit. Compare the delay of the circuit with that of a ripple carry adder. (17)

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Contd ... Q. No. 5

(b) Show the circuit diagram of the square version of a 4×4 bit array multiplier. Explain the operation of the circuit. (18)

6. (a) (i) Show the circuit diagram of a 2×2 SRAM array which uses 6-transistor memory cell as basic storage cell. Clearly show the row select, column select, pre-charge and sense signal in your circuit.

(ii) Explain how the READ and WRITE operation are performed showing the second row and first column cell as an example.

(iii) Explain how sense amplifier reduces the READ time of the cell. (20)

(b) A 4-bit datapath consists of register, ALU and a shifter. Show two possible bus architectures of the system such that an addition operation of two operand stored in the register and storing the result back in the register can be computed in atmost two clock cycles. (15)

7. (a) Using a structured design approach, develop a bus arbitration logic for n-line bus such that access is given to the highest priority line. If priority is given according to ascending order (line N highest priority) draw the circuit and stick diagram of a basic leaf cell. (17)

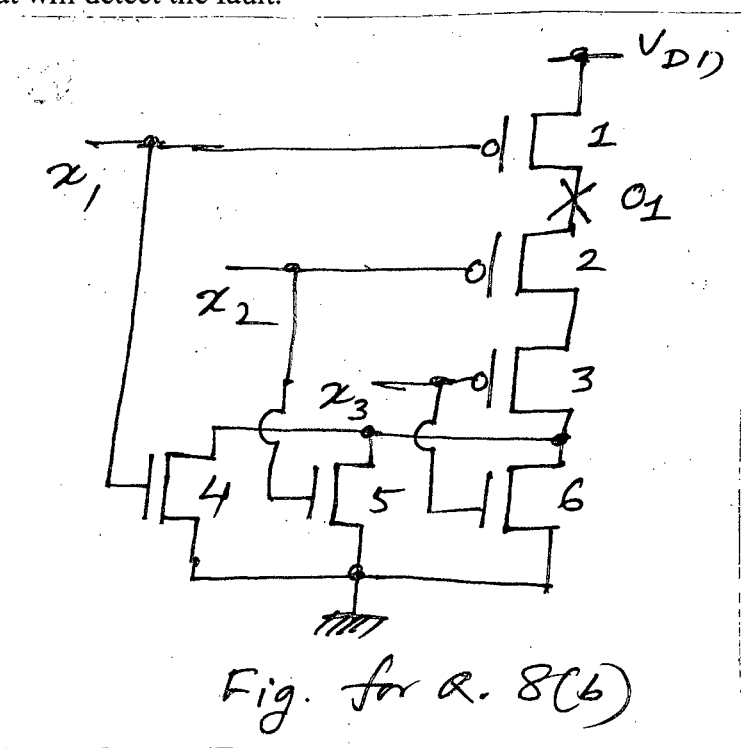
(b) Draw the Schematic diagram at transistor level of a CMOS PLA to implement the functions. (18)

$$z_1 = a.\bar{b} + c.\bar{d}$$

$$z_2 = a.\bar{b} + c.d$$

8. (a) Draw and explain the operation of a (i) tri-state pad, (ii) bidirectional pad with the help of a truth table. (20)

(b) In the figure shown below transistor 1 is stuck opens (O_1). Find all the two pattern test vectors that will detect the fault. (15)



BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 433** (Microwave Engineering)

Full Marks: 210

Time : 3 Hours

The questions are of equal value.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this Section. Answer any **THREE**.

4 Smith charts will have to be supplied to each student.

1. (a) Starting with the voltage and current wave equations, deduce the analytical expression of input impedance of an ideal transmission-line of length l_2 having characteristic impedance Z_0 and terminated with a mismatched load Z_L in terms of reflection coefficient ρ , Z_0 and the phase constant β .
 (b) Starting with the analytical expression of the input impedance, deduce the expression of input impedance of a 2.75λ long transmission-line of characteristic impedance Z_0 terminated with a load impedance Z_L .
 (c) A microwave generator operating at 2.0 GHz feeds into a 20 cm long transmission-line of characteristic impedance 50 ohms filled up with a dielectric of $\epsilon_r = 1.5$. At a plane in the middle of the line, the input impedance looking toward the load is $40 - j40$ ohms. (i) Find the distance in cm of the 1st V_{\min} from the plane toward the load. (ii) Find the distance in cm, from the plane toward the load, of the 1st position where the input impedance becomes complex conjugate of the input impedance of the 1st plane. (Use Smith chart).

2. (a) With necessary diagrams and sketches briefly explain how with the help of a Smith transmission-line chart one can obtain (i) the magnitude and angle of reflection coefficient from a knowledge of input impedance at a point of a microwave transmission-line, (ii) the input impedance of a short circuited transmission line of length l and characteristic impedance Z_0 .
 (b) A lossless transmission line filled up with a dielectric of $\epsilon_r = 1.5$ has a characteristic impedance of 75 ohm and is terminated with a mismatched load. The VSWR on the line is 3 and the 1st voltage minimum is 2 cm from the load. The distance between two nulls of the standing wave pattern is 5 cm when the load is replaced by a short. Determine the load impedance. (Use Smith chart).
 (c) A microwave generator operating at 3GHz feeds into a 25 cm long transmission-line of characteristic impedance 50 ohms filled up with a dielectric of $\epsilon_r = 1.5$. At a plane in the middle of the line, the input impedance looking toward the load is $50 - j75$ ohms.

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

- (i) What is the reflection coefficient at a point 2.412 cm away from the plane toward the load.
 - (ii) Find the distance in cm of the 1st V_{\max} position from the plane toward the load.
 - (iii) Find the VSWR at the load plane.
3. (a) With analytical deductions show how a piece of quarter wave long transmission line can eliminate mismatch on a transmission line. What needs to be done if it is desired that the characteristic impedance of the quarter wave long transmission line must be real if the load impedance is complex?
- (b) Write the steps (of the procedure) which need to be followed to solve a single stub impedance matching problem.
- (c) A microwave generator operating at 4 GHz feeds into a 30 cm long transmission-line of characteristic impedance 50 ohms. A load of $25 + j30$ ohms is connected at the end of the transmission-line. A single stub tuner is to be connected with this system located at a distance d from the load plane toward the generator to obtain matching. Find the distance d in cm and the length of the stub l in cm for perfect match. The dielectric material of the transmission line has a dielectric constant of 1.4. Give all possible solution. (Use Smith chart).
4. (a) With neat diagrams and appropriate labeling briefly write about the construction of a Rectangular Microwave cavity Resonator. Draw its lumped parameter equivalent circuit.
- (b) With necessary diagrams, list the methods of coupling to such resonators.
- (c) Write the expressions of the field quantities inside a rectangular cavity resonator assuming TE_{101} mode is excited inside the cavity.
- (d) An air-filled rectangular cavity is made of copper plates. The length 'd' of the cavity is equal to its breadth 'a' and its breadth 'a' is equal to its height 'b'. The length of the cavity is 3.352 cm. Considering the maximum electric field strength in the transverse plane is 100 volts/meter and taking $R_s = 0.0261$ ohm for copper conductor at the resonant frequency, calculate the quality factor Q and bandwidth of the cavity.

SECTION – B

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

5. (a) Starting with the field expressions for TE waves in a rectangular waveguide deduce the expressions of field quantities, the cut-off frequency, guide-wavelength and wave importance for TE_{10} wave in a rectangular waveguide. What are the advantages of TE_{10} mode compared to other modes in a rectangular waveguides?

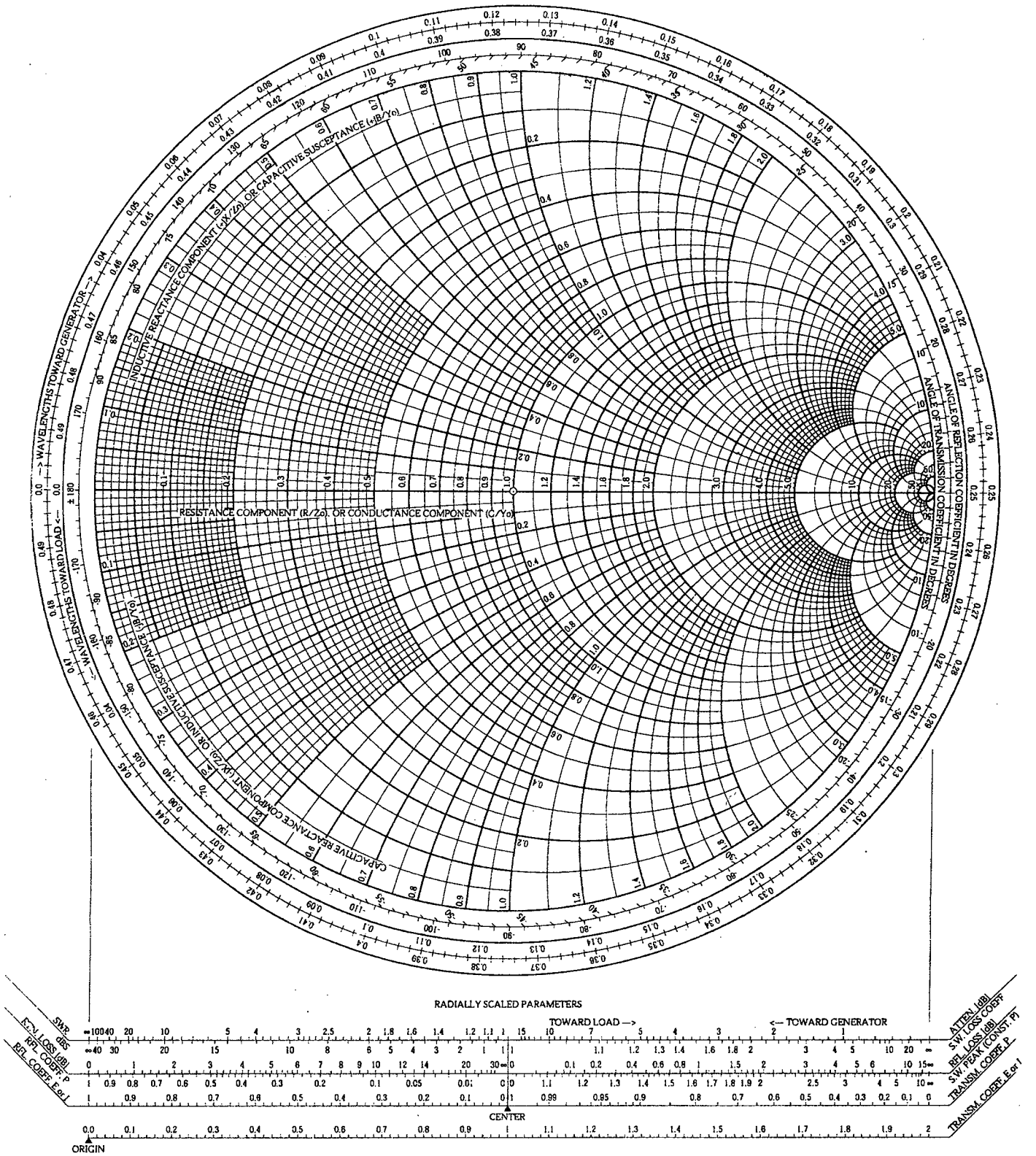
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Contd ... Q. No. 5

- (b) A rectangular waveguide filled with a dielectric material of $\epsilon_r = 2.5$ has a height of $b = 1.5$ cm. For propagation of TE_{10} mode, calculate the dimension of the waveguide width if the cut-off frequency for this waveguide is 12 GHz. Calculate the (i) Cut-off wavelength of this guide, (ii) the phase velocity of a wave through this guide at 18 GHz and (iii) the wave impedance at 18 GHz.
6. (a) Deduce the analytical expressions for the components of the electric and magnetic fields and the radiation resistance of a one wavelength long straight dipole antenna.
(b) Compute the current required to produce 200 watts of total radiated power at 4 GHz from a small current element antenna of length 0.75 cm. Also compute the current required to produce the same amount of total radiated power from a 3.75 cm long dipole antenna operating at 4 GHz.
7. (a) Deduce the expressions of beamwidths of an endfire and a broadside array. With necessary diagrams write about the phase scanning of antenna arrays.
(b) With neat diagrams and appropriate labeling briefly write about the construction and the principle of operation of a Gunn Oscillator.
8. (a) With neat diagrams describe the construction and working principle of a reflex klystron oscillator.
(b) With neat diagrams describe the construction and working principle of a magnetron oscillator.
-

The Complete Smith Chart

Black Magic Design



BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA

L-4/T-1 B. Sc. Engineering Examinations 2010-2011

Sub : **EEE 471** (Energy Conversion III)

Full Marks: 210

Time : 3 Hours

The figures in the margin indicate full marks.

USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION – AThere are **FOUR** questions in this Section. Answer any **THREE**.

1. (a) Explain the principle of energy conversion for generator and motor action. (10)
(b) State the assumptions and derive the mechanical force expression of a singly excited magnetic field system. (25)
2. (a) Define cross-field generators. Prove mathematically that a large amplification taken place in an amplidyne. (17)
(b) Describe the construction and operation of a Van-De-Graf generator. (18)
3. With neat sketches explain the construction and operation of the following machines (35)
(a) Linear Induction Motor (LIM)
(b) Induction and conduction pump
(c) Shaded pole motor
4. (a) Define fuel cells. What are its classifications? Can fuel cells be considered as a renewable energy source? (12)
(b) Explain the operation of the following fuel cells with neat diagrams and appropriate reactions. (23)
(i) Proton Exchange Membrane Fuel Cell
(ii) Molten Carbonate Fuel cell
(iii) Solid Oxide Fuel Cell.

SECTION – BThere are **FOUR** questions in this Section. Answer any **THREE**.

5. (a) With neat sketches explain the operation of a Schrage motor. Describe the speed control of Schrage motor using secondary winding. (17 $\frac{1}{2}$)
(b) How “voltage build up” takes place in induction generator? Describe the operation of capacitor excited induction generator. (17 $\frac{1}{2}$)

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6. (a) Classify reluctance motors. Briefly explain the operation of a switched reluctance motor. (17 $\frac{1}{2}$)
- (b) Mention the methods of gate pulse generation for the power switches of brushless dc motor. Describe any one of the methods. (17 $\frac{1}{2}$)
7. (a) Explain the operation and derive the Torque expression of an electrostatic motor. (17 $\frac{1}{2}$)
- (b) With neat sketches explain the construction and operation of an electrostatic machine providing rotational motion. (17 $\frac{1}{2}$)
8. (a) How solar cell works? From the equivalent circuit and I-V curve of a solar cell define MPPT. (12)
- (b) Classify and briefly describe solar PV power systems. (12)
- (c) Describe charge controlling mechanisms for PV systems. (11)
-

SECTION – A

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

1. (a) Discuss in detail, the steps involved in a CVD process. (15)
 (b) How does the cvd oxide differ from the epitaxial oxide? (12)
 (c) Briefly explain the non-optical lithography. (8)
2. (a) Explain the scotch-tape technique to fabricate graphene sheet. (8)
 (b) Discuss the atomistic model of diffusion. (12)
 (c) Discuss, with appropriate figures, the APCVD, PECVD and LPCVD techniques. (15)
3. (a) Upon what parameters does the process of oxidation depend on? Briefly discuss. (12)
 (b) A silicon wafer is doped at 10^{15} cm^{-3} p-type. The wafer is heated to $1100 \text{ }^\circ\text{C}$ for 1.0 hr. If the wafer is in a dry oxygen atmosphere, how much will the oxide grow? (15)
 $A \equiv 0.09, \quad B \equiv 0.027, \quad \tau \equiv 0.076$
 [the symbols have their usual meaning and proper units.]
 (c) What are the fabrication challenges for storage devices? (8)
4. (a) Explain the MBE process with appropriate figures. (15)
 (b) For Si_3N_4 and GaAs films, which etching techniques (dry versus wet) would you recommend, why? (12)
 (c) Compare sputtering and implantation techniques. (8)

SECTION – B

Question No. 8 is mandatory, Answer any **TWO** out of the remaining **THREE**

5. (a) What are the criteria that a metal system must meet for making good ohmic contacts? (13)
 (b) Explain in detail the two methods of depositing metals on semiconducting layers. (22)
6. (a) What are the types of contaminants that the semiconductor industry are vulnerable to? Discuss. (22)
 (b) Compare a class – 100 and a class – 10000 cleanroom. (13)

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7. (a) Briefly compare the Intel 22 nm and 32 nm processing techniques. **(13)**
- (b) Briefly mention the major limiters of the semiconductor process. yield output. **(12)**
- (c) Calculate maximum wavelength at which the emitted power is maximized if the grey body temperature is 600 °C, compare it with that of the sun's surface (6000 °C). **(10)**
8. Write short notes on the following: **(35)**
- (a) Ohmic contact
 - (b) Nano technology
 - (c) Pyrometric technique
 - (d) Rapid Thermal Processes
 - (e) Cleanrooms
-