[Time: 3 Hours] **[Marks:75]**

N.B.: 1. Question No.1 is compulsory.
2. Attempt any three from remaining five questions.
3. Assume suitable data if any required.

Q.1 Solve **any four** 20

a) State and prove the convolution property of Fourier transform.

b) Determine initial and final value of x(n) If x (z) = $\frac{z}{z^2-\frac{3}{2}z+\frac{1}{2}}$ $|z| > \frac{1}{2}$

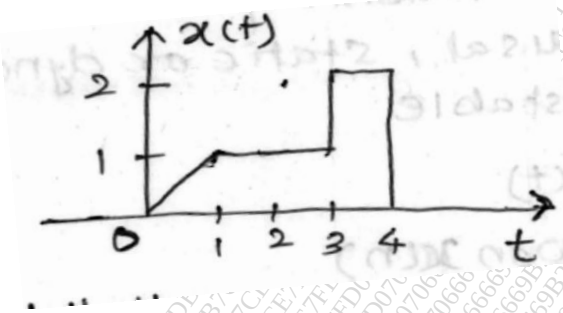
c) State and prove the parsaval theorem.

d) Explain Gibb's phenomenon.

e) Sketch one sided and both sided magnitude and phase spectra

X(t) = 4 + 6 sin $\left(4\pi t - \frac{\pi}{3}\right)$ + 8 cos $\left(8\pi t - \frac{\pi}{4}\right)$

Q.2 a) Express the following signal in functional from. 05



b) Whether the following signal in energy or power. Also find its energy or power x(n)= u(n) 05

c) Obtain the convolution of two continuous signal given below. Also sketch the result. 10

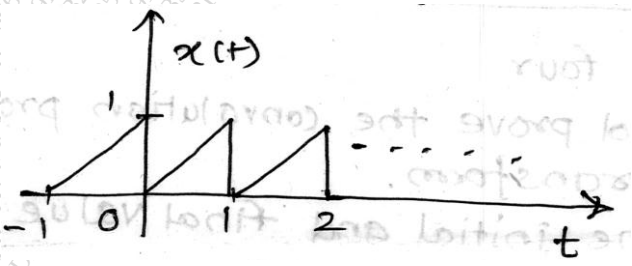
x(t)=1 for $0 \leq t \leq 1$

0 otherwise

h (t)=1 for $0 \leq t \leq 1$

-1 $1 \leq t \leq 2$

Q.3 a) Find the exponential Fourier series coetticient of following signal. 10



b) Given $\frac{d^{2y(t)}}{dt^2} + \frac{8dy(t)}{dt} + 15y(t) = 3\,x(t)$ 10

determine

i) Impulse response of system.

ii) Response to the input $x(t) = 2e^{-3t}u(t)$

Q.4 a) Find the z-transform of x (z) by using p. f. $x(z) = \frac{z}{z^2+z+1}$ 10

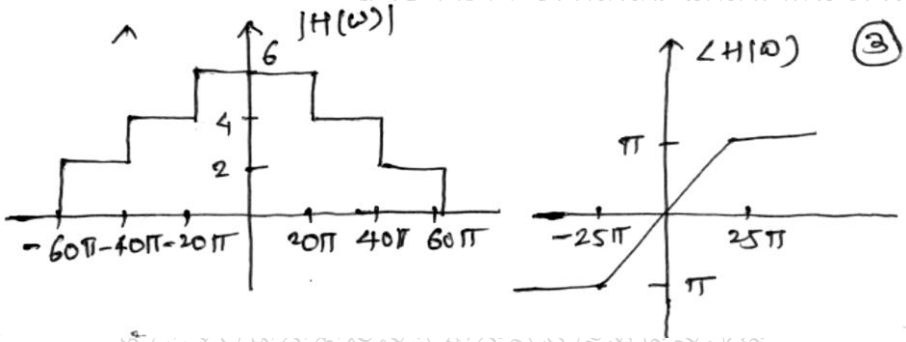
b) Find the following systems are linear / nonlinear, time variant /invariant, causal / noncausal, static or dynamic, stable or unstable. 10

$y(+) = t\,x(t)$

$y(n) = \cos wn\, x(n)$

Q.5 a) Final the inverse Laplace transform for all passible roc condition. $X(s) = \frac{s+3}{(s+1)(s+4)^3}$ 10

b) Consider the following system with magnetude and phase response as shown in figure. 05



Find the o/p for the input $x(t) = 4\sin(30\pi t) + 6\cos\left(50\pi t + \frac{\pi}{3}\right)$

c) Find the fourier transform of signum function. 05

Q.6 Obtain 10

i) Z –transform of

$x(n) = n\left(\frac{1}{4}\right)^n u(n) + u(n-1)$

ii) Laplace transform of

$X(t) = te^{-4t}u(t) + tu(t+1)$

A discrite time LTI system is specified by $y(n) = -7y(n-1) - 12y(n-2) + 4x(n-1) - 2x(n)$ where $y(-1) = -2$ $y(-2) = 3$. Determine 10

i. Zero in put response

ii. Zero state response where $x(n) = u(n)$

iii. Total response.

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3 Hours **[Total Marks: 80]**

N.B. (1) Question no 1 is **compulsory.**
(2) Attempt any **three** questions out of remaining **five** questions.
(3) Assume suitable data if necessary.
(4) Figure to the right indicates full marks.

Q. 1 Answer the following questions. (Attempt any **FIVE**) **20**
a) Explain bit addressable memory of 8051.
b) Give the function of following Instruction-
i) CJNE A, #45H,12H, ii) MOVC A, @A+DPTR.
c) Differentiate between timer and counter operation of 8051.
d) Explain the Difference between Microprocessor and Microcontroller.
e) Interface LED to 8051 microcontroller. Write a program to toggle LED.
f) Explain Power Saving and Power Down mode.

Q. 2 a) Draw and explain the Architecture of 8051 microcontroller **10**
b) What is Embedded system? Explain the design metrics of Embedded system. **10**

Q. 3 a) Write an assembly language program to convert two ASCII numbers into packed BCD Number. **10**
b) Explain the addressing mode of 8051 microcontroller with example. **10**

Q. 4 a) Write a program to transmit message "INSTRUMENTATION" serially at 9600 baud rate. **10**
b) Draw and Explain the interface of LCD. Write a program to display "Good Morning" on this display. **10**

Q.5 a) Interface 7 Segment Display with 8051 and write a program to display 0-9 counter with predetermined delay. **10**
b) Interface DAC with 8051 microcontroller and write a program to generate square wave continuously. **10**

Q.6 a) Explain the automatic washing machine system by using 8051 microcontroller. **10**
b) Explain the interrupt structure of 8051 microcontroller in details. **10**

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Duration: 3 Hours **Max. Marks 80**

N.B.

1. **Q.1** is compulsory. Attempt **any three** from the remaining questions.
2. All questions carry equal marks.
3. Figures to the Right indicate full marks.
3. Assume suitable data if necessary

Q.1 Attempt **any four** **20**

a. Obtain the state space representation for following system in diagonal form

$$G(s) = \frac{1}{s^2 + 0.3s - 0.02}$$

b. Obtain the transfer function for the following system.

$$\begin{aligned} \dot{x} &= \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \\ y &= \begin{bmatrix} 1 & 0 \end{bmatrix} x \end{aligned}$$

c. Explain PD compensator. Why it is required? Draw a typical circuit diagram for PD compensator.

d. Define controllability and stabilizability.

e. For the system

$$G(s) = \frac{s+1}{s(s+3)}$$

check if $s = -2$ pole is on root locus or not.

f. Write Cayley Hamilton theorem. Check if it holds for the matrix $F = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$.

Q.2 A. Check for the controllability and observability of the system, **10**

$$\begin{aligned} \dot{z}_1 &= -z_1 + u \\ \dot{z}_2 &= -2z_2 + z_3 \\ \dot{z}_3 &= -2z_3 + u \\ y &= z_1 + z_3 \end{aligned}$$

using Kalman's tests.

B. Represent the system transfer function **10**

$$G(s) = \frac{s + 0.5}{s^2 + 3s + 2}$$

in **(i)** controllable canonical form **(ii)** diagonal form.

Q.3 A. Design the lag compensator using root-locus for the system **10**

$$G(s) = \frac{1}{s(s+5)}$$

such that dominant closed loop poles are at $s_d = -1.91 \pm j1.78$.

B. Write the steps to design lead compensator using Bode plot. **10**

Q.4 A. Design the state feedback control for the system **10**

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1.32 & 2.32 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

to place the poles at $-1, -2$.

B. Obtain $x(t)$ for the system **10**

$$\dot{x} = \begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} \mathrm{u}$$

if initial condition is $x(0) = [1 \ 1]^\top$.

Q.5 A. Prove the non-uniqueness of state space representation using similarity transformation. Also prove that eigenvalues of system are invariant under linear transformation. **10**

B. A system is given by **10**

$$\begin{aligned} \dot{x} &= \begin{bmatrix} -4 & 1 \\ -3 & 0 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u \\ y &= [1 \ 0]\, x \end{aligned}$$

Design the observer that has poles at $-12, -15$.

Q.6 Write short notes on **20**

A. Ziegler-Nichols method for PID controller tuning.

B. Lag-lead compensator.

[Time: Three Hours] **[Marks:80]**

N.B:
1. Question.No.1 is compulsory.
2. Attempt any three questions from the remaining five questions
3. Draw neat diagrams wherever required
4. Assume suitable data if necessary.

1 Attempt **any four.** **20**

a. Explain Solid State Relay and Reed Relay.
b. Illustrate and explain Sequence valves.
c. What are the uses of Relief valve?
d. Explain current to pressure converter.
e. Give the applications, advantages and disadvantages of Needle valve.

2 a. Explain Control valve terminologies. State need and specifications of Control Valve. **10**
b. Brief about special types of pneumatic valve: Pilot-operated valves and Non-return valves **10**

3 a. What are the auxiliary process control components? State the need for safety valves in industry. **10**
b. Draw and explain Hydraulic pumps: centrifugal pumps, gear pumps and lobe pumps. **10**

4 a. Draw and Explain Flow characteristics of the control valve (Inherent and Installed). **10**
b. Draw and brief about Air supply system and its components. **10**

5 a. Explain desirable features of SMART transmitter. **10**
b. Draw and explain Rotary switches, Selector switches and thumbwheel switches. **10**

6 Write a short note on:- **20**

a. Toggle switches
b. Hydraulic actuators
c. Two and Three wire transmitters.
d. Pinch Valve

(3 Hours) **Total Marks: 80**

N. B. 1) Question No. **1** is **compulsory**.
2) Answer any **3** questions from the remaining **5** questions.
3) Assume suitable data wherever necessary.

Q1 Solve any four **20**
(a) Explain MEMS fabrication technique LIGA.
(b) Explain important properties of chemical sensors.
(c) Write note on sensors for food processing like smell or odour, taste.
(d) Give comparative study of thermal sensors.
(e) Explain working principle of digital humidity temperature smart sensor.

Q2 (a) Explain various techniques of etching for MEMS sensor fabrication **20**
(b) Explain photolithography technique used in MEMS.

Q3 (a) Explain briefly:- **20**
(1) Surface processing using sputtering
(2) Chemical vapor deposition
(b) Explain selection criteria for various transducers? Also elaborate design considerations for sensor fabrication.

Q4 (a) Explain in brief **20**
i) ADXL 345
ii) MEMS gyroscope

(b) Give comparative study of analog to digital converters used for sensor signal conditioning.

Q5 (a) Write about different materials used in sensor fabrication. **20**
(b) Explain in detail differences between thin film and thick film sensors.

Q6 Write short note. (Any Four) **20**
a) Surface and bulk micro machining
b) Any one application of optical sensors
c) Biological Oxygen Demand (BOD)
d) Agriculture measurements such as soil moisture, wind speed, leaf wetness duration
e) Measurement of carbon dioxide (COx)

(3 hours) **[Total marks 80]**

N.B.: (1) Question no. 1 is compulsory

(2) Write any 3 questions from remaining

(3) Figures to the right indicates full marks

1. **Attempt any four.** **(20)**

a. Modern Communications could not exist without Fiber Optics. Explain and justify this statement.

b. Classify FOS.

c. Explain in details splices and connectors.

d. Explain any two concepts of pressure measurement fiber optic sensors.

e. Explain principle of working of PIN with their characteristics.

2. **a.** Find the core radius necessary for single mode operation at 820 nm of step index fiber with $n_1 = 1.482$ and $n_2 = 1.474$. **(10)**

What is the numerical aperture and maximum acceptance angle of this fiber?

Also calculate the corresponding solid angle.

b. Explain intermodal and intramodal dispersion in optical fibers. **(10)**

How dispersion does affects the transmission bandwidth of optical fiber.

3. **a.** What is dispersion in single mode fiber? What is Fiber Bragg Grating? **(10)**

Explain with suitable diagram working of "Optical Fiber Bragg Grating".

b. Give details of Beam splitters, opto isolators, optical modulators and optical switches. **(10)**

4. **a.** Differentiate between Pre-Amplifier, Booster Amplifier and In-line Amplifier w.r.t fiber optic instrumentation. **(10)**

b. Explain in details the Intensity-type fiber optic sensor using micro-bending for Liquid Level Measurement. **(10)**

5. **a.** Explain various concepts of temperature measurement using fiber optic technique. **(10)**

b. Compare LED and APD with respect to fiber optics. **(10)**

6. **a.** Explain phase modulated sensors and wavelength modulated sensors. **(10)**

b. Explain OTDR measurement **(05)**

c. Identify (introduce) fiber optics sensors. **(05)**
