ii. For each of the following impulse responses, determine whether the corresponding system is (i) memory-less, (ii) causal and (iii) stable. Justify your answer. **6**

(a) $h[n] = (2)^n u[-n]$

(b) $h[n] = e^{2n} u[n-1]$

(c) $h[n] = \left(\frac{1}{2}\right)^n u[n]$

OR iii. Calculate $y[n], n = 0,1,2,3$ for the first order recursive system $y[n] - (1/2)y[n-1] = x[n]$ if the input is $x[n] = u[n]$ and initial condition $y[-1] = -2$. **6**

Q.6 Attempt any two:

i. Determine the $z-$transform of the signal$x[n] = \alpha^n u[n]$. Depict the ROC and the locations of the poles and zeros of $X(z)$ in $z-$plane. **5**

ii. Find the inverse $z-$transform of $X(z) = \frac{1}{1-\frac{1}{2}z^{-1}} + \frac{2}{1-2z^{-1}}$ assuming that signal is causal. **5**

iii. Determine whether the LTI system $y[n] - (6/5)y[n-1] - (16/25)y[n-2] = 2x[n] + x[n-1]$ is clausis or not. **5**

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Enrollment No......................................

Faculty of Engineering

End Sem (Odd) Examination Dec-2017

EC3CO01 / EI3CO01 Signals and Systems

Programme: B.Tech. Branch/Specialisation: EC/EI

Duration: 3 Hrs. **Maximum Marks: 60**

Note: All questions are compulsory. Internal choices, if any, are indicated. Answers of Q.1 (MCQs) should be written in full instead of only a, b, c or d.

Q.1 i. Consider the periodic signal $e^{-t/2}$, $0 \leq t \leq 2$, with period $T = 2$. What is its power? **1**

(a) $\left(1-\frac{1}{e}\right)$ (b) $(e-1)$ (c) $\frac{1}{2}\left(1-\frac{1}{e^2}\right)$ (d) $\frac{1}{2}(e^2-1)$

ii. The power of a sinusoidal signal $x(t) = Acos(2\pi ft)$ is **1**

(a) 1 (b) 0 (c) $\frac{A^2}{2}$ (d) $\frac{A}{2}$

iii. Consider the unit-step function $u(t)$ defined as,$u(t) = 1\ if\ t > 0, \frac{1}{2}$ at $t = 0$ and $0\ if\ t \leq 0$. What is its Fourier transform? **1**

(a) 1 (b) $\delta(f)$ (c) $\frac{1}{j2\pi f}$ (d) $\frac{1}{2}(\delta(f)+\frac{1}{j2\pi f})$

iv. Consider the impulse train $(t) = \sum_{n=-\infty}^{\infty} \delta(t - nT_s)$. What is its discrete Fourier series representation? **1**

(a) $\frac{1}{T_s}\sum_{k=-\infty}^{\infty} \delta(f - \frac{k}{T_s})$ (b) $\delta(f)$

(c) $\sum_{k=-\infty}^{\infty} \delta(f - \frac{k}{T_s})$ (d) $\sum_{k=-\infty}^{\infty} sinc(kT_s)\delta(f - kT_s)$

v. Consider a system with input $x(t)$ and output $y(t)$ given by $y(t) = x(t)\sum_{n=-\infty}^{\infty} \delta(t - nT)$. The system is **1**

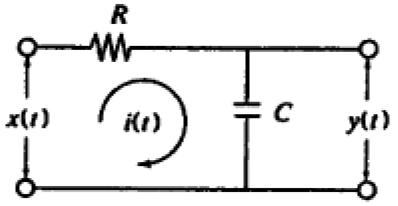
(a) Linear and Time invariant

(b) Linear and not-time invariant

(c) Non-linear and time invariant

(d) Non-linear and not-time invariant

vi. Consider the RC network shown in the figure below. Find its impulse response $h(t)$. **1**



(a) $\frac{1}{RC}\left(1-e^{-t/RC}\right)u(t)$ (b) $sinc(\frac{t}{RC})$

(c) $\frac{1}{RC}\left(e^{-t/RC}\right)u(t)$ (d) $\frac{1}{(1+(\frac{t}{RC})^2)}$

vii. The causal sequence defined by $x[n]=3(-1)^n, n\geq 0$ and 0 for $n<0$ has **1**

(a) Finite energy with zero power
(b) Infinite energy with finite average power=4.5
(c) The data is insufficient
(d) None of these

viii. If the output of the system is $y[n]=\sum_{k=-\infty}^{n} x[k]$ with an input $x[n]$, the system will work as **1**

(a) Accumulator (b) Adder
(c) Subtractor (d) Multiplier

ix. According to Time shifting property of z-transform, if $X(z)$ is the z-transform of $x[n]$ then what is the z-transform of $x[n-k]$? **1**

(a) $z^k X(z)$ (b) $z^{-k}X(z)$ (c) $X(z-k)$ (d) $X(z+k)$

x. What is the z-transform of the signal defined as $x[n]=u[n]-u[n-N]$? **1**

(a) $\frac{1+z^N}{1+z^{-1}}$ (b) $\frac{1-z^N}{1+z^{-1}}$ (c) $\frac{1+z^{-N}}{1+z^{-1}}$ (d) $\frac{1-z^{-N}}{1-z^{-1}}$

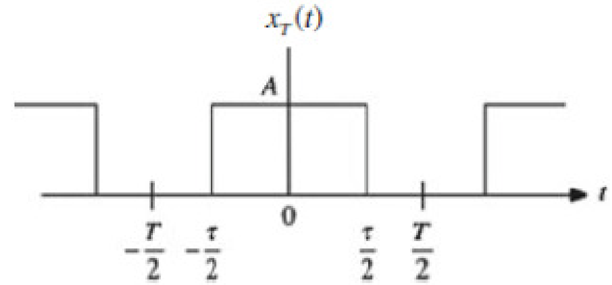
Q.2 i. What is Impulse function? Define sifting property of impulse. **2**

ii. Differentiate between energy and power signals with examples. **3**

iii. Compute the energy of the signal $x(t)=\sin(2\pi f_0 t)$. **5**

OR iv. What are orthogonal signals? What is the necessary condition for orthogonality? Give one example. **5**

Q.3 i. Find and plot the complex Fourier series of the pulse sequence shown in following figure. **2**

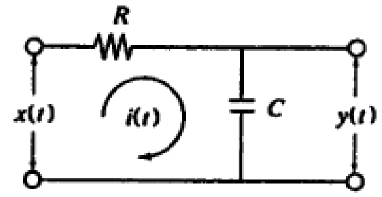


ii. Consider the impulse train $(t)=\sum_{n=-\infty}^{\infty}\delta(t-nT_s)$. What is its discrete Fourier transform? **8**

OR iii. If $x_1(t)$ and $x_2(t)$ are periodic signals with period T and their Fourier series expressions are $x_1(t)=\sum_{n=-\infty}^{\infty} d_n e^{j2\pi f_0 t}$ and $x_2(t)=\sum_{n=-\infty}^{\infty} e_n e^{j2\pi f_0 t}$, $f_0=\frac{1}{T}$ show that the signal $x(t)=x_1(t)x_2(t)$ with period T can be expressed as $x(t)=\sum_{n=-\infty}^{\infty} d_k e_{n-k} e^{j2\pi f_0 t}$. **8**

Q.4 i. What are LTI systems? Demonstrate distortion less transmission. **3**

ii. Consider the RC network shown in the figure below. Find its unit step response. **7**



OR iii. Consider the continues time system described by input output relation $y(t)=x(t)x(t-1)$. Show that this system is non-linear. **7**

Q.5 i. Consider a system with impulse response $h[n]=\left(\frac{3}{4}\right)^n u[n]$. Determine the output of the system at time $n=-5, n=5$ and $n=10$ when the input is $x[n]$. **4**

Medicaps University

End Sem (odd) Exam Dec 2017

EC3CO01 / EI3CO01 Signal & System

Programme: B Tech. Branch: EC/EI

Solution / Marking Scheme

MCQ

Q. 1 (i) (c) $\frac{1}{2}(1 - 1/e^2)$

(ii) (c) $A^2/2$

(iii) (d) $\frac{1}{2}\left[\delta(f) + \frac{1}{2\pi f}\right]$

(iv) (a) $\frac{1}{T_s}\sum_{K=-\infty}^{\infty} \delta\left(f - \frac{K}{T_s}\right)$

(v) (b) linear and not-time invariant

(vi) (c) $\frac{1}{RC}\left(e^{-t/RC}\right)u(t)$

(vii) (b) Infinite Energy with finite avg Power $= 4.5$

(viii) (a) Accumulator

(ix) (b) $z^{-K} X(z)$

(x) (d) $\frac{1 - z^{-N}}{1 - z^{-1}}$

Q. 2 (i) Impulse definition $\delta(t) = 0 \quad t \neq 0$

$\int_{-\infty}^{\infty} \delta(t)\,dt = 1$ — 1 mark

sifting property $\int_{-\infty}^{\infty} x(t)\,\delta(t)\,dt = x(t)\Big|_{t=0} = x(0)$

Either for continuous or discrete. — 1 mark

Q. 2 (ii)

Define Energy Signal with Exmple - 1.5 M

— " — Power Signal —"— - 1.5 M

(iii) Define Energy Signal + formula - 2 M

steps + calculation of Energy - 3 M

Ans $\boxed{\text{Energy} = \infty}$ Joules

OR

(IV) orthogonal Signal defination → 2 M

Necessary condition → 1 M

Example of orthogonal fun with proof → 2 M

Q. 3 (i)

Formula Exponential / Trigonometric

$x(t) = \sum_{n=-\infty}^{\infty} X_n e^{jn\omega_0 t}$ Fourier series → 1 M

calculation X_n & plot → 1 M

$X_n = \frac{1}{T}\int_0^T x(t)\, e^{-jn\omega_0 t}\, dt$

(ii) Attempting the Question get full marks → 8 M

Q3

OR (iii)

Proof By Fourier series

convolution Property

Fourier series — 2M

convolution Property ⟶ 2M

Proof statement ⟶ 4M

Q. 4

(I) LTI System

Linear system defination ——— 1.5 M
& conditions

Time Invariant —"— ⟶ 1.5 M
& —"—

★ Distortionless transmission ——— Out of syllabus

(II)

Equation of RC Network ⟶ 2M
& laplace transform

finding I(S) ⟶ 1M

finding Y(S) ⟶ 1M

Inverse laplace Y(S) i.e

$\boxed{y(t) = u(t) - e^{-t/RC} u(t)}$ ⟶ 3M

(III)

For given problem additivity Proof ⟶ 3M

—"— homogenity Proof ⟶ 3M

comment on Result ⟶ 1M

Q. 5 (I) Attempting the question get full marks —— 4M

(II)

	Static/memoryless	Causual	Stable	
(a)	* Data is Insufficient for memoryless check	Non Causual	Stable	→ 2M
(b)		Causual	Unstable	→ 2M
(c)		Causual	Unstable	→ 2M

(III) $y[n] = y_g(n) + y_p(n)$

$y_g(n) = K \cdot (1/2)^n$ —— 2M

$y_p(n) = K(1/2)^n + \alpha / K_1$ —— 2M

finding α or K_1 coeff $= 2$

Solution

$y(0) = 0$
$y(1) = 1$
$y(2) = 3/2$
$y(3) = 7/4$

→ 2M

Q. 6 Attempt any two

(1) Z transform finding

$X(z) = \frac{1}{1-az^{-1}} = \frac{z}{z-a}$ → 3M ROC $|z|>a$

ROC define & its plot → 1M

location pole/zero → 1M

Q.6

(ii)

$$x(z) = \frac{1}{1-\frac{1}{2}z^{-1}} + \frac{2}{1-2z^{-1}}$$

Inverse ZTx for causual signal

$$x(n) = \left(\tfrac{1}{2}\right)^n u(n) + 2\cdot(2)^n u(n)$$

2.5 M + 2.5 M

(iii) LTI System.

$$y(n) - 6/5\, y(n-1) - 16/25\, y(n-2) = 2x(n) + x(n-1)$$

causuality define —— 1 M

causuality proof —— 4 M

by any method. for given problem

* —— * —— * —— *