

GATE

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**This book is dedicated to all
Electronics Communication Engineers
preparing for
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Er. R.K. Rajesh
(DIRECTOR)

ATE examination is one of the most prestigious competitive examination conducted for graduate engineers. Over the past few years, it has become more competitive as a number of aspirants are increasingly becoming interested in M.Tech & government jobs due to decline in other career options.

In my opinion, GATE exam test candidates' basics understanding of concepts and ability to apply the same in a numerical approach. A candidate is supposed to smartly deal with the syllabus not just mugging up concepts. Thorough understanding with critical analysis of topics and ability to express clearly are some of the pre-requisites to crack this exam. The questioning & examination pattern has changed over the past few years, as numerical answer type questions play a major role to score a good rank. Keeping in mind, the difficulties of an average student, we have composed this booklet. **We are thankful to Er. KUNAL SRIVASTAVA (AIR 1 ESE 2012, AIR 44 GATE 2013 in ECE) for preparing this booklet.**

In Electronics Communication Engineering, over 2,50,000 candidates appeared in GATE 2013 with 36,394 finally qualified. The cut-off marks for general category is 25. For more details log onto our institute's website <http://www.engineersinstitute.com/> Electronics

Established in 2006 by a team of IES and GATE toppers, we at **Engineers Institute of India** have consistently provided rigorous classes and proper guidance to engineering students over the nation in successfully accomplishing their dreams. We believe in providing exam-oriented teaching methodology with updated study material and test series so that our students stay ahead in the competition. The faculty at EII are a team of experienced professionals who have guided thousands to aspirants over the years. They are readily available before and after classes to assist students and we maintain a healthy student-faculty ratio. Many current and past year toppers associate with us for contributing towards our goal of providing quality education and share their success with the future aspirants. Our results speak for themselves. Past students of EII are currently working in various government departments and PSU's and pursuing higher specializations at IISc, IITs , NITs & reputed institutions.

Best wishes for future career.

R.K. Rajesh

Director

Engineers Institute of India

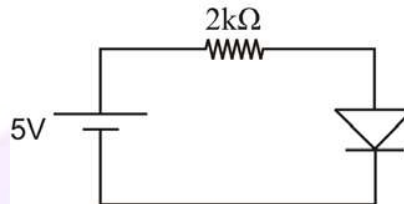
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1. ANALOG ELECTRONICS

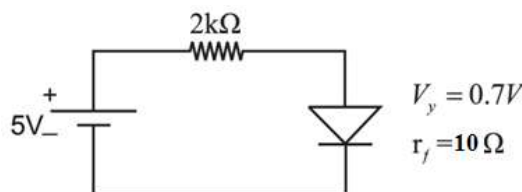
- (1.) Consider a Si p.n diode with doping concentrations, $N_a = 10^{16} / \text{cm}^3$ and $N_d = 10^{15} / \text{cm}^3$. If $n_i = 1.5 \times 10^{10} / \text{cm}^3$ and zero bias junction capacitance = 0.5pF. The junction capacitance at an applied reverse bias of 2V is:
- (a.) 0.5pF (b.) 0.245pF (c.) 0.168pF (d.) 2.0698pF
- (2.) If at the doping levels of $N_D = 10^{17} / \text{cm}^3$. And $N_A = 10^{16} / \text{cm}^3$ and at a reverse bias of 1V, a Si diode shows a junction capacitance of 0.5pF, find the zero bias junction.
- (a.) 0.76pF (b.) 1.16pF (c.) 0.86pF (d.) 1.31pF
- (3.) Consider a silicon p – n diode with reverse saturation current, $I_o = 10^{-13} \text{A}$. Find the power dissipated in the $2\text{k}\Omega$ resistor.



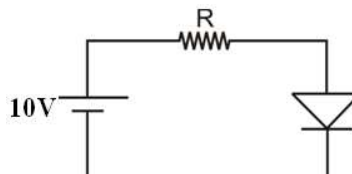
- (a.) 20mW (b.) 19.2mW (c.) 8mW (d.) 9.6mW

2 Linked Questions:

- (4.) Find the power in the $2\text{k}\Omega$ resistor if the diode has a cut in voltage = 0.7V and d.c. forward resistance = 10Ω



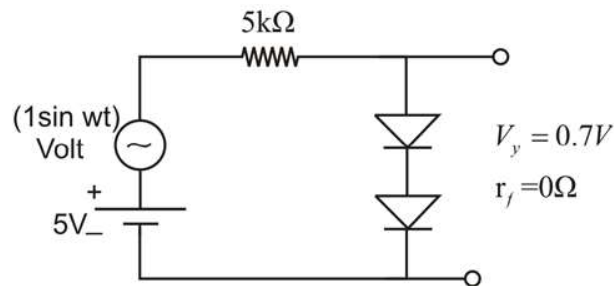
- (a.) 8mW (b.) 16.7mW (c.) 9.15mW (d.) 19.1mW
- (5.) Find the power consumed in the diode in the previous question
- (a.) 1.5mW (b.) 9.15mW (c.) 1.4mW (d.) 0.046mW
- (6.) If in the following circuit, diode has a power rating of 1mW, with a cut in voltage = 0.7V and zero forward resistance, find which of the following values of “R” will meet the requirement.



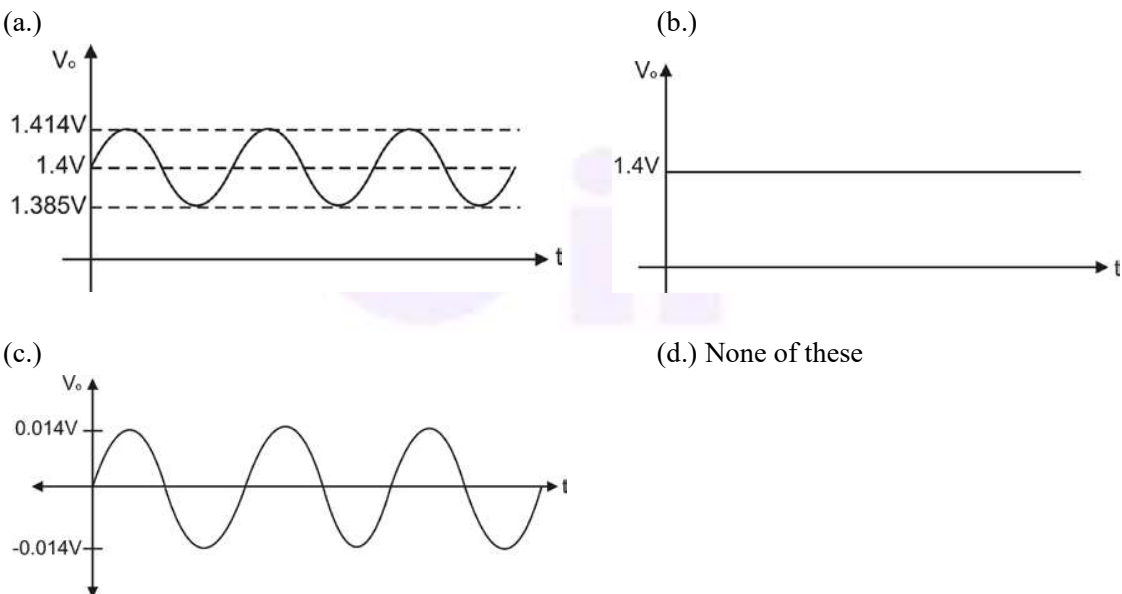
- (a.) 3kΩ (b.) 7kΩ (c.) 3.97kΩ (d.) 6.5kΩ

4 Linked Questions:

Consider the following circuit.

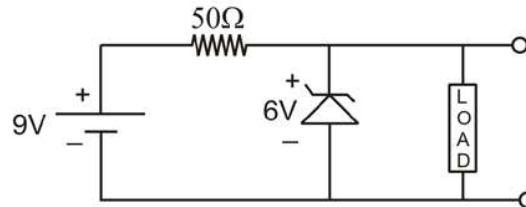


- (7.) Find the d.c component of the diode current.
 (a.) 1mA (b.) 0.86mA (c.) 0.72mA (d.) 0.58mA
- (8.) Find the d.c output voltage V_o .
 (a.) 1.4V (b.) 0.7V (c.) 3.6V (d.) 4.3V
- (9.) Find the dynamic diode conductance, assuming room temperature of 300K.
 (a.) 26mA/V (b.) 55.38mA/V (c.) 33.1mA/V (d.) 27.7mA/V
- (10.) Which of the following best shows the output voltage V_o v/s time graph?



- (11.) If a diodes dynamic resistance is 52Ω at 300K, find the d.c diode current.
 (a.) 1mA (b.) 2mA (c.) 0.5mA (d.) None of these
- (12.) If a voltage regulator has an unregulated voltage supply of 20V, and it gives output as follows:
 (i) No – load voltage = 10V
 (ii) Full – load voltage = 8V with load current = 1mA
 Find the percentage regulation and load resistance.
 (a.) 80%, $10k\Omega$ (b.) 80%, $8k\Omega$ (c.) 25%, $8k\Omega$ (d.) 25%, $10k\Omega$

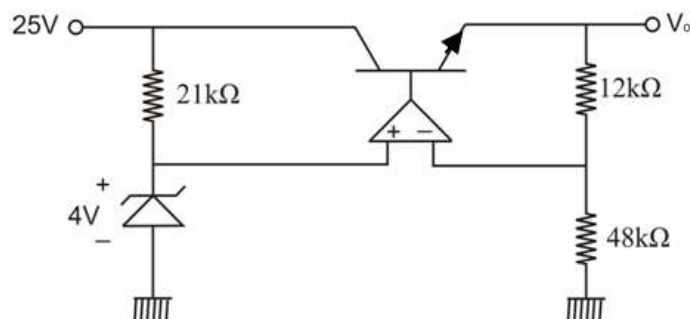
- (13.) The zener diode as shown below has a knee current of 5mA and a maximum allowed power dissipation of 300mW. What are the minimum and maximum load currents that can be drawn, keeping $V_o = 6V$?



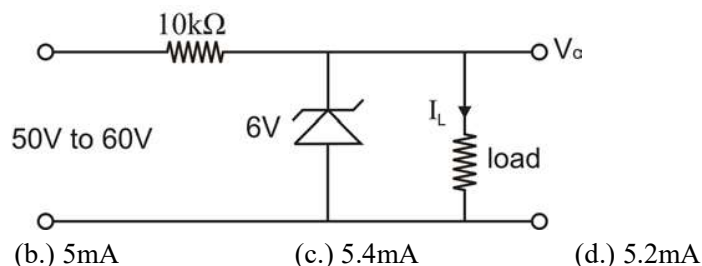
- (a.) 0mA, 180mA (b.) 5mA, 110mA (c.) 10mA, 55mA (d.) 60mA, 180mA

2 Linked Questions:

- (14.) Find the output voltage and power dissipated in the zener diode if the zener diode has a zener voltage of 4V

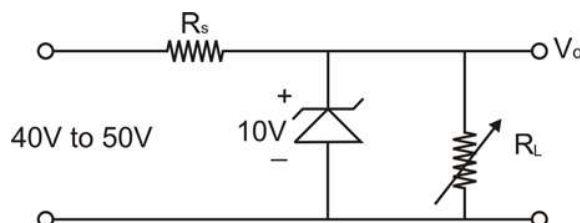


- (a.) 5V, 4mW (b.) 5V, 21mW (c.) 20V, 4mW (d.) 20V, 21mW
- (15.) If the input supply voltage is increased by 20%, find % change in the power of the transistor.
 (a.) 25% increase (b.) 25% decrease (c.) 50% increase (d.) None of these
- (16.) Consider the following circuits with zener voltage = 6V and knee current of 0.2mA. Find the maximum load current that can be drawn.



- (a.) 4.8mA (b.) 5mA (c.) 5.4mA (d.) 5.2mA

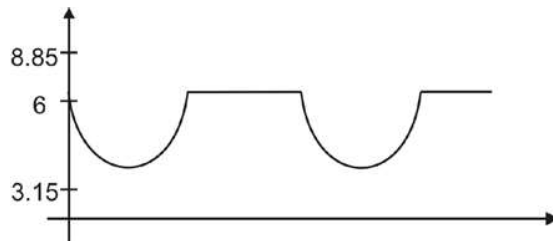
2 Linked Questions:



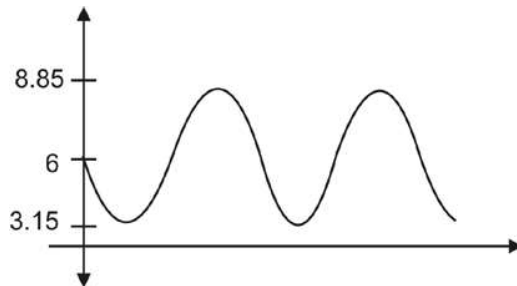
Assuming the zener diode has a knee current of 0.5mA and a power rating of 300mW. The load current can vary from 1mA to 50mA

- (79.) Which of the following graph best shows the variation of collector to emitter voltage against time?

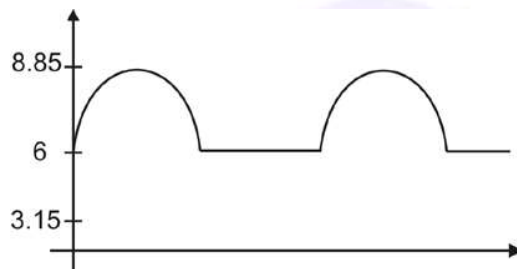
(a.)



(b.)



(c.)



(d.) None of these

- (80.) Which of the following is the correct expression for total collector currents

(a.) 1mA (b.) $0.475 \sin \omega t$ mA
(c.) $1 + 0.475 \sin \omega t$ mA (d.) $1 - 0.475 \sin \omega t$ mA

- (81.) The power consumed by the transistor in one full cycle of the input signal is:

(a.) 2.66mW (b.) 2.323mW (c.) 4.646mW (d.) 5.32mW

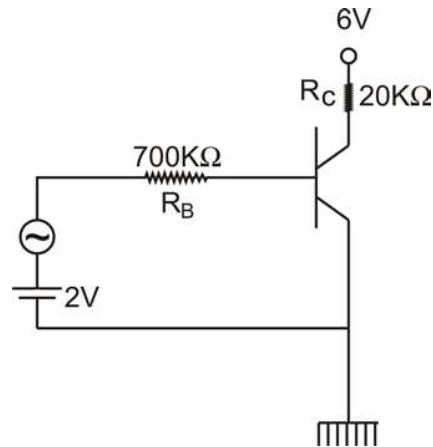
- (82.) To work as an amplifier, the B.J.T must be biased in _____ region and FET must be biased in _____.

(a.) Linear, saturation (b.) Saturation, linear
(c.) Saturation, saturation (d.) None of these

- (83.) If a BJT is biased with $10\mu\text{A}$ of base current ($\beta = 100$) and has an early voltage of 50V, find the small signal output resistance.

(a.) 200Ω (b.) 500Ω (c.) $50\text{k}\Omega$ (d.) $5\text{M}\Omega$

(84.) Find the small signal voltage gain of the following circuit

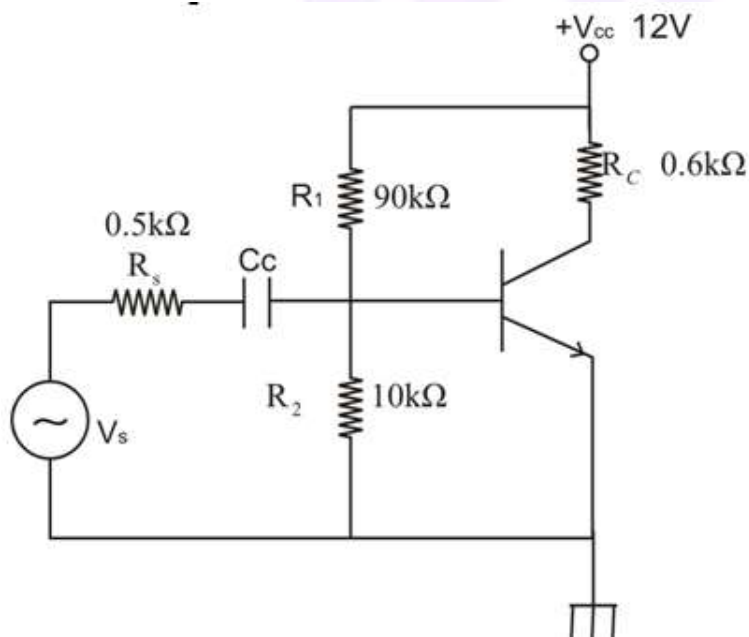


$$\beta = 100, V_{BE(on)} = 0.7V$$

- (a.) -142.866
- (b.) +2.8
- (c.) -2.8
- (d.) +142.86

5 Linked Questions:

Consider the following common – emitter circuit



$$\beta = 100$$

$$V_{BE(on)} = 0.7V$$

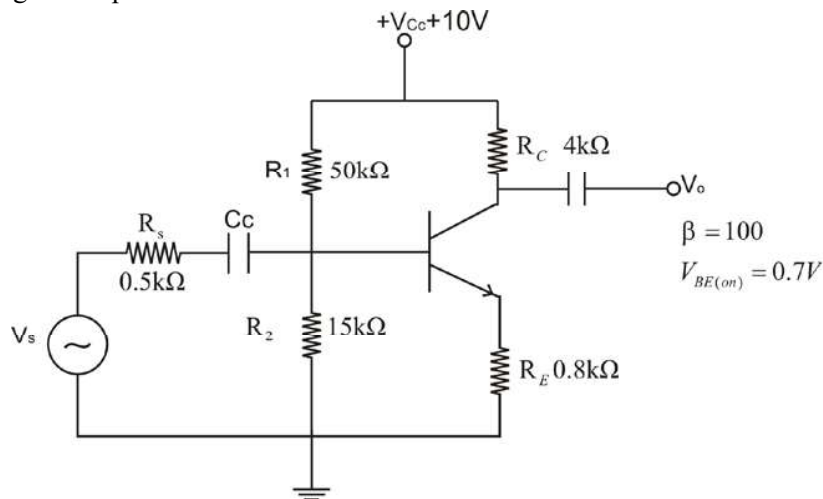
(85.) Find the d.c. collector current (I_{CQ}) and d.c collector to emitter voltage drop (V_{CEQ})

- (a.) 8.67mA, 5.56V
- (b.) 5.56mA, 8.67V
- (c.) 5.56mA, 5.56V
- (d.) 8.67mA, 8.67V

- (86.) Find its small – signal voltage gain
 (a.) -120.24 (b.) -28.31 (c.) -128.20 (d.) -60.120
- (87.) Due to presence of R_s , the series resistance of the voltage source, the magnitude of the voltage gain of the circuit _____.
 Due to some non – zero early voltage, the magnitude of the voltage gain _____.
 (a.) Decreases, increases (b.) Decreases, decreases
 (c.) Increases, decreases (d.) Increases, increases
- (88.) Find the a.c. input resistance of the above CE amplifier
 (a.) $100\text{k}\Omega$ (b.) $9\text{k}\Omega$ (c.) $0.468\text{k}\Omega$ (d.) $0.4448\text{k}\Omega$
- (89.) Find the a.c. output resistance of the above CE amplifier
 (a.) $\infty\text{k}\Omega$ (b.) $0.6\text{k}\Omega$ (c.) $0.255\text{k}\Omega$ (d.) None of these

7 Linked Questions:

Consider the following CE amplifier circuit.



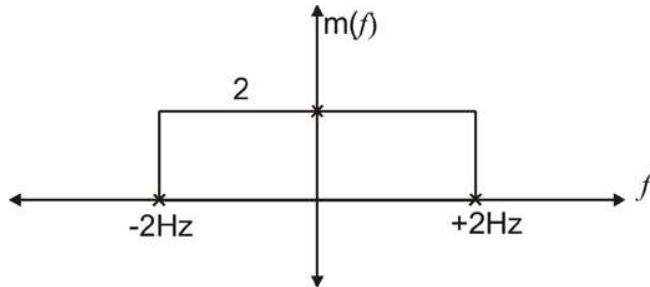
- (90.) The d.c. collector current and the d.c collector to emitter voltage drop is:
 (a.) 1.74mA , 3.04V (b.) 1.042mA , 5V
 (c.) 0.13mA , 9.4V (d.) 1.74mA , 1.643V
- (91.) The transconductance (g_m) and the base to emitter diffusion resistance (r_π) is:
 (a.) 1.494mA/V , $66.92\text{k}\Omega$ (b.) 66.92mA/V , $1.494\text{k}\Omega$
 (c.) 66.92mA/V , $0.0149\text{k}\Omega$ (d.) 1.494mA/V , $0.06692\text{k}\Omega$
- (92.) The input resistance looking into the base terminal is:
 (a.) $11.53\text{k}\Omega$ (b.) $1.25\text{k}\Omega$ (c.) $82.2\text{k}\Omega$ (d.) $1.4\text{k}\Omega$
- (93.) The input resistance of the amplifier is:
 (a.) $82.2\text{k}\Omega$ (b.) $5.67\text{k}\Omega$ (c.) $10.12\text{k}\Omega$ (d.) $11.53\text{k}\Omega$

2 Linked Questions:

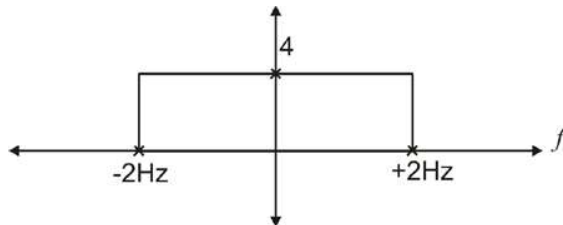
Consider a real signal $m(t)$ operated upon to produce $y(t) = m(t) + j\hat{m}(t)$.

(Where $\hat{m}(t)$ denotes the Hilbert's transform of $m(t)$).

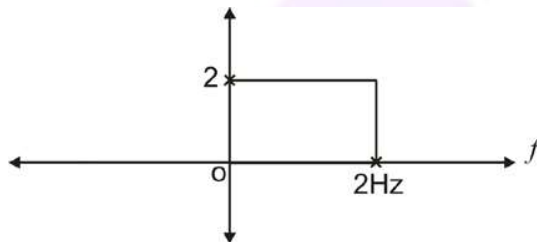
(19.) The Fourier transform of $y(t)$ will be, if spectrum of $m(t)$ is as shown:



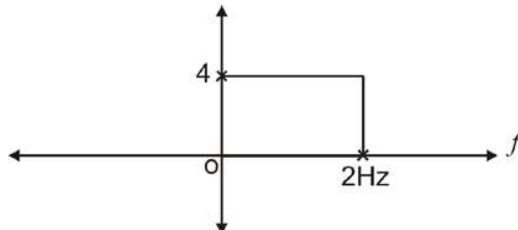
(a.)



(b.)



(c.)



(d.) None of these

(20.) The real part of $[y(t).e^{-j\omega_c t}]$ corresponds to a:

- (a.) DSB wave (b.) SSB lower side band (c.) SSB upper side band (d.) None

(21.) Five modulated signals are to be sent over a channel which supports 20kHz only. If all five signals are modulated with message frequency = 1kHz, and the first two are A.M. next is D.S.B. and the last two are S.S.B, find the maximum guard band available for transmission.

- (a.) 8kHz (b.) 12kHz (c.) 3kHz (d.) None of these

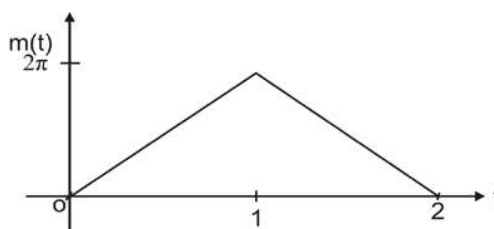
- (22.) The number of modulated signals that can be accommodated in a 30 kHz bandwidth, if each signal was A.M by a message frequency of 2kHz and guard bands are also 2kHz, is:
 (a.) 5 (b.) 6 (c.) 4 (d.) 3
- (23.) The instantaneous frequency of the signal $f(t) = \cos 1000\pi t \cdot \cos(10 \cdot \sin 20\pi t) - \sin 1000\pi t \cdot \sin(10 \cdot \sin 20\pi t)$ varies from :
 (a.) 400Hz to 600Hz (b.) 500Hz , no oscillations
 (c.) 450Hz to 550Hz (d.) 1200Hz to 800Hz.

2 Linked question

Consider an angle – modulated signal,

$$x_c(t) = 5 \cdot \sin(2 \times 10^6 \pi t + 9 \cdot m(t))$$

Where $m(t)$ is as shown:



- (24.) The maximum phase deviation obtained for $x_c(t)$ is:
 (a.) 18 radians (b.) 18π radians (c.) 9π radians (d.) 9 radians
- (25.) The maximum frequency deviation and the peak frequency of the modulated signal is:
 (a.) $9\text{Hz}, (10^6 + 9)\text{Hz}$ (b.) $18\pi\text{Hz}, (10^6 + 18\pi)\text{Hz}$
 (c.) $18\pi\text{Hz}, (2\pi \times 10^6 + 18\pi)\text{Hz}$ (d.) $9\pi\text{Hz}, (2\pi \times 10^6 + 9\pi)\text{Hz}$

2 Linked Questions:

Consider the message signal $m(t) = 10 \cos(2000\pi t)$ and $c(t) = 100 \cdot \cos(2\pi \times 10^6 \times t)$

- (26.) If frequency modulated with $k_F = 10\pi \text{ rad/V}$ the peak frequency deviation and maximum frequency of the modulated waveform will be:
 (a.) $100\text{Hz}, (10^6 + 100)\text{Hz}$ (b.) $100\text{Hz}, (2\pi \times 10^6 + 100\pi)\text{Hz}$
 (c.) $50\text{Hz}, (10^6 + 50)\text{Hz}$ (d.) None
- (27.) The modulation index and bandwidth will be for F.M.
 (a.) 0.05; 2000Hz (b.) 20; 21kHz (c.) 0.5; 2000Hz (d.) None

2 Linked Questions:

An angle modulated signal is described as

$$x_c(t) = 10 \cos[2\pi 10^6 t + 0.1 \sin(10^3 \pi t)]$$

- (28.) Considering $x_c(t)$ as an FM signal with $k_F = 10\pi \text{ rad/V}$; find the message signal $m(t)$
 (a.) $10 \cdot \cos(10^3 \pi t)$ (b.) $\frac{5}{\pi} \cdot \cos(10^3 \pi t)$ (c.) $20\pi \cdot \cos(10^3 \pi t)$ (d.) None

- (29.) Considering $x(t)$ as a P.M signal, with $k_p = 10 \text{ rad/V}$. Find $m(t)$.
 (a.) $0.01 \sin(10^3 \pi t)$ (b.) $0.01 \cos(10^3 \pi t)$ (c.) $1. \sin(10^3 \pi t)$ (d.) None
- (30.) Consider an F.M. signal with expression:
 $x_c(t) = 10 \cos[2\pi(10^6 t) + 8 \sin(2\pi \times 10^3 t)]$
 Now if the amplitude of the modulating signal is doubled and the frequency of the modulating signal is halved, the new modulation index and the new bandwidth will be:
 (a.) 8; 18kHz (b.) 2; 1.5kHz (c.) 32; 33kHz (d.) 32; 66 kHz

2 Linked Questions:

Consider $c(t) = 5. \cos[2\pi 10^6 t]$ and, $m(t) = \cos[4\pi \times 10^3 t]$.

- (31.) If the two signals are used to generate A.M. with $\mu = \frac{1}{\sqrt{5}}$, find the A.M bandwidth and power.
 (a.) 4kHz; 13.75W (b.) 4kHz; 30W (c.) 2kHz; 15W (d.) 2kHz; 30W
- (32.) Find the coefficient of the term $\cos[2\pi \times (1008 \times 10^3 t)]$ in the F.M., if maximum frequency deviation in F.M. is three times the bandwidth of A.M.
 (a.) $5J_4(6)$ (b.) $5J_6(4)$ (c.) $J_4(6)$ (d.) $J_6(4)$
- (33.) Consider a frequency of " f_m " Hz used in an A.M. and F.M. system. When modulated, the peak frequency deviation of the F.M. is three times the bandwidth of the A.M. The magnitude of those sidebands placed at $\pm f_m$ Hz from the carrier in both the system is equal. Also, the total average powers are also same in both the cases. Find the modulation indices of the F.M. and the A.M. respectively. If $J_1(6) = -0.28$
 (a.) 6, -0.28 (b.) 6, 0.28 (c.) 0.61, 6 (d.) 6, 0.61
- (34.) Consider a receiver tuned to 1000 kHz frequency with an intermediate frequency of 455kHz. Let "I" denote the image frequency then I =
 (a.) 1900kHz (b.) 1910 kHz (c.) 545kHz (d.) 1455kHz

2 Linked Questions:

Consider a standard A.M receiver.

Intermediate frequency = 500 kHz.

Range of frequencies to be received = 550kHz to 1650 kHz

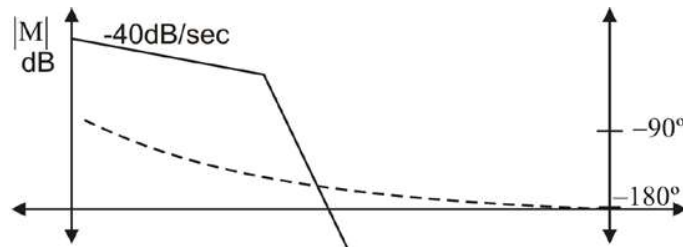
Assume that the local oscillator frequency can be suitably varied by changing the capacitance value. Let

$R = \frac{C_{\max}}{C_{\min}}$; $C_{\max}$ and $C_{\min}$ are the two extreme values of the local oscillator capacitance corresponding to

the range of signal frequencies to be received

- (35.) If the local oscillator works as a down converter with $f_{Lo} > f_{\text{signal}}$, R =
 (a.) 2.047 (b.) 4.19 (c.) 529 (d.) 23
- (36.) If the local oscillator works as a down converter with $f_{Lo} < f_{\text{signal}}$, then R =
 (a.) 2.047 (b.) 4.19 (c.) 529 (d.) 23

- (85.) Consider the following Bode plot:



Where the solid line represents magnitude plot and the dashed line is phase plot. Then G.M. and P.M. are respectively:

- (a.) $G.M. > 0$, $P.M. > 0$ (b.) $G.M. > 0$, $P.M. < 0$
 (c.) $G.M. < 0$, $P.M. > 0$ (d.) $G.M. < 0$, $P.M. < 0$
- (86.) An open loop transfer function

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

with unity negative feedback will have its break points at _____

and asymptotic angles of _____ in its root locus.

- (a.) $-5, \pm 90^\circ$ (c.) $-2.5, \pm 90^\circ$ (e.) $+5, \pm 180^\circ$ (d.) $+2.5, \pm 180^\circ$

- (87.) Calculate the break – point and the value of “k” at the break – point for a unity negative feedback

$$\text{system with } G(s).H(s) = \frac{k}{s(s+1)(s+3)}$$

- (a.) $s = -0.45, k = 0.631$ (b.) $s = -2.21, k = 0.631$
 (c.) $s = -2.21, k = -2.11$ (d.) $s = -0.45, k = -2.11$

4 Linked Questions

Consider an open loop transfer function of a unity negative feedback system,

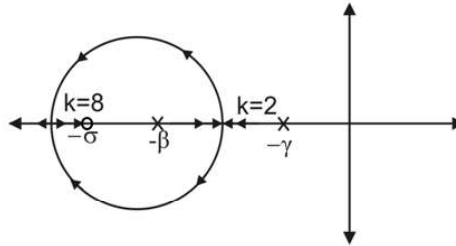
$$G(s).H(s) = \frac{k}{s(s+1)(s+2)}$$

- (88.) The breakaway point and the value of “k” at that point are:
 (a.) $s = -0.422, k = 3.85$ (b.) $s = -1.57, k = 3.85$
 (c.) $s = -1.57, k = 0.385$ (d.) $s = -0.422, k = 0.385$
- (89.) The asymptotic angles and the point of intersection of the asymptotes at the real axis are:
 (a.) $60^\circ, 180^\circ, 300^\circ; s = -1$ (b.) $60^\circ, 180^\circ, 300^\circ; s = -1$
 (c.) $30^\circ, 180^\circ, 300^\circ; s = -3$ (d.) $30^\circ, 180^\circ, 300^\circ; s = -3$
- (90.) The point of the intersection of the root locus with the vertical axis and the value of “k” at this point are:
 (a.) $s = \pm j\sqrt{2}, k = 12$ (b.) $s = \pm j\sqrt{2}, k = 6$
 (c.) $s = \pm j\sqrt{2/3}, k = 12$ (d.) $s = \pm j\sqrt{2/3}, k = 6$
- (91.) The point of intersection of the asymptotic angle lines with the vertical axis are:
 (a.) $\pm j\frac{1}{\sqrt{3}}$ (b.) $\pm j\sqrt{3}$ (c.) $\pm j\sqrt{2}$ (d.) None of these

- (92.) Consider two points, $s_1 = -3 + j4$ and $s_2 = -3 - j2$. If we have an open loop function

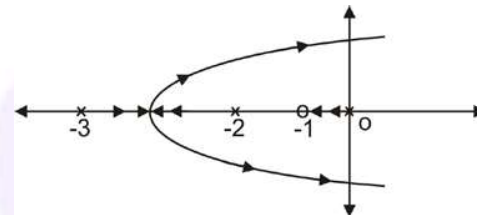
$$G(s).H(s) = \frac{k}{(s+1)^4}, \text{ which point lies on the root locus?}$$

- (a.) s_1 (b.) s_2 (c.) both (d.) neither
- (93.) Consider an open – loop transfer function $G(s).H(s) = \frac{k.(s+\sigma)}{(s+\gamma)(s+\beta)}$. The following is its root locus plot.



The system behaves as critically damped for what values of k?

- (a.) $2 \leq k \leq 8$ (b.) $K = 2$ (c.) $K = 8$ (d.) $K = 2$ and $k = 8$
- (94.) Obtain the open loop transfer function of the following root locus?

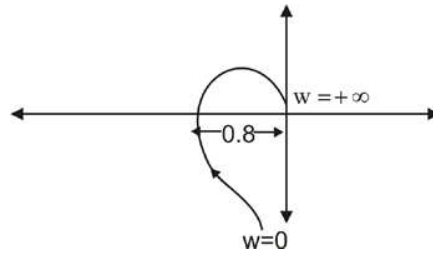


- (a.) $\frac{k}{s(s+1)(s+2)}$ (b.) $\frac{k(s+1)}{s(s+2)(s+3)}$ (c.) $\frac{k(s+1)}{s(s+2)}$ (d.) None

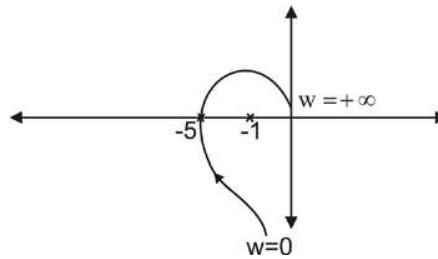
2 Linked Questions

Consider an open loop transfer function $G(s).H(s) = \frac{k(s^2+16)}{s(s+4)}$

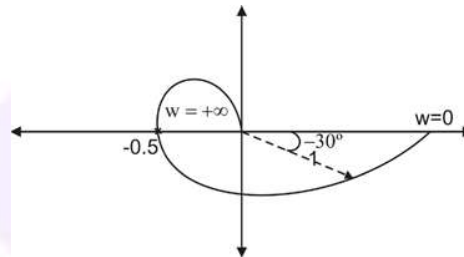
- (95.) Find the value of k at the break point
 (a.) $K = 0.20710$ (b.) $K = 10.88$ (c.) $K = 0.7094$ (d.) $K = 1.4096$
 ANS: (a)
- (96.) Calculate the angles of arrival at the complex zeroes, with (+) angle in anti – clockwise direction
 (a.) $\pm 225^\circ$ (b.) $\pm 180^\circ$ (c.) $\pm 185^\circ$ (d.) None of these
- (97.) Consider an open loop transfer function $G(s) = \frac{k}{s(s^2+7s+12)}$ with unity negative feedback.
 The value of “k” for which $s = (-1 + j1)$ lies on the root locus is:
 (a.) 4 (b.) 5.5 (c.) 6.5 (d.) 10
- (98.) Consider an open loop system with unity negative feedback, such that $G(s).H(s) = \frac{k}{s(s^2+4)}$
 The angle of departure of the complex poles is:
 (a.) $\pm 90^\circ$ (b.) $\pm 0^\circ$ (c.) $\pm 180^\circ$ (d.) None of these
- (99.) The gain margin of the following Nyquist plot is:



- (a.) 0.515dB (b.) 1.94dB (c.) -1.94dB (d.) -0.515dB
- (100.) The G.M of the following Nyquist plot is:



- (a.) +13.98dB (b.) -13.98dB (c.) -0.0715dB (d.) +0.0715dB
- (101.) Find the gain and phase margins of the following Nyquist plot:



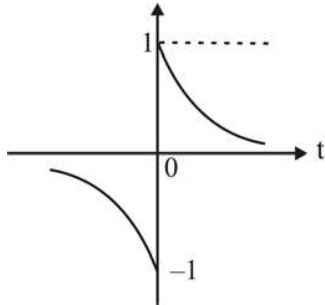
- (a.) 6dB, 120° (b.) 6dB, 150° (c.) -6dB, 30° (d.) -6dB, -30°
- (102.) The polar plot of $G(s)H(s) = \frac{100}{s(s+1)^2}$ intersects the real axis at $\omega = \omega_p$, and at $(-k, 0)$. Then the values of ω_p and k are respectively.
- (a.) 1rad/s , 50 (b.) π rad/s , -50 (c.) 1rad/s , -50 (d.) π rad/s , 50
- (103.) If the open loop transfer function is $G(s)H(s) = \frac{10}{(s+1)^4}$. Find its G.M
- (a.) 2.5dB (b.) 0.4dB (c.) -7.95dB (d.) +7.95dB
- (104.) If the Nyquist plot passes through $(-1, 0)$, the G.M. is (in dB)
- (a.) 0 (b.) Negative (c.) Positive (d.) And positive value.
- (105.) The phase margin of a system with $G(s)H(s) = \frac{29}{(s+2)^2}$ is:
- (a.) -136.3° (b.) 136.3° (c.) -43.5° (d.) 43.5°
- (106.) The order and type of the open loop system function (assuming there are no zeroes) is:

EXP: $x(t) = e^{-at}u(t) + e^{at}u(-t)$

↑ F.T.

$$X(\omega) = \frac{1}{a + j\omega} + \frac{1}{a - j\omega} = \frac{2a}{a^2 + \omega^2}$$

Let $x_1(t) = e^{-at}u(t) - e^{at}u(-t)$



$$\left\{ \begin{aligned} X_2(\omega) &= \frac{1}{a + j\omega} - \frac{1}{a - j\omega} \\ X_2(\omega) &= -\frac{2j\omega}{a^2 + \omega^2} \end{aligned} \right\}$$

$$\lim_{a \rightarrow 0} x_1(t) = u(t) - u(-t) = \text{sgn}(t)$$

$$\lim_{a \rightarrow 0} X_2(\omega) = \frac{2}{j\omega}$$

(47.) **ANS:** (b)

EXP: For example $\sin \omega_0 t$ is not absolutely integrable but its Fourier transform exists, though not well-defined at all points.

(48.) **ANS:** (d)

EXP:

$$\text{sgn}(t) = 2u(t) - 1$$

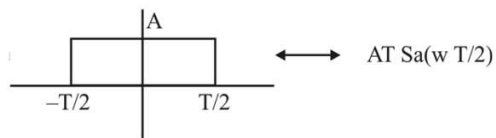
$$u(t) = \frac{1 + \text{sgn}(t)}{2}$$

$$u(t) \xrightarrow{\text{F.T.}} \frac{2\pi\delta(\omega) + 2/j\omega}{2}$$

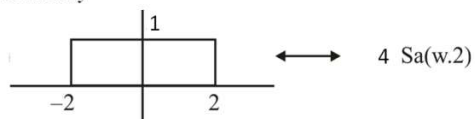
$$u(t) \longleftrightarrow \frac{1}{j\omega} + \pi\delta(\omega)$$

For $y(t) = \mu(t+2) - \mu(t-2)$

We know



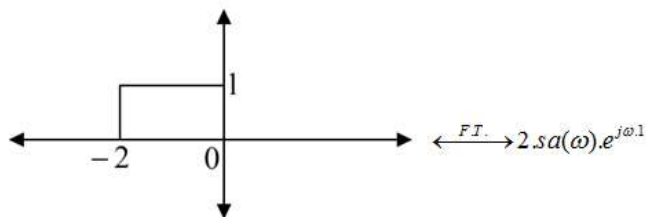
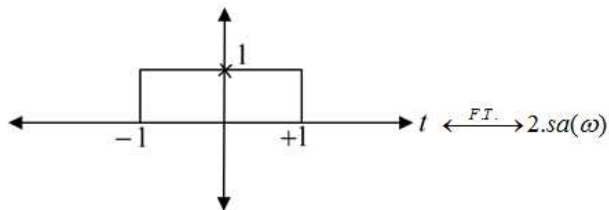
Similarly



(49.) **ANS:** (c)

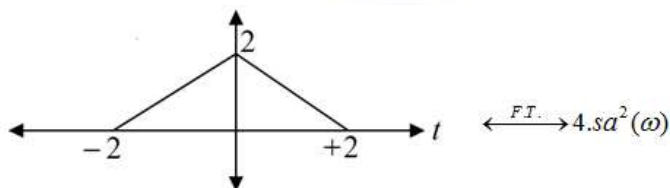
(50.) ANS: (c)

EXP:

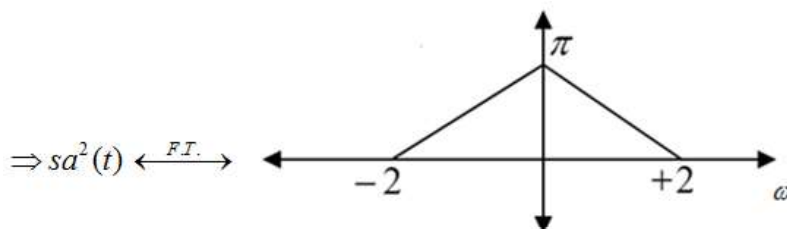
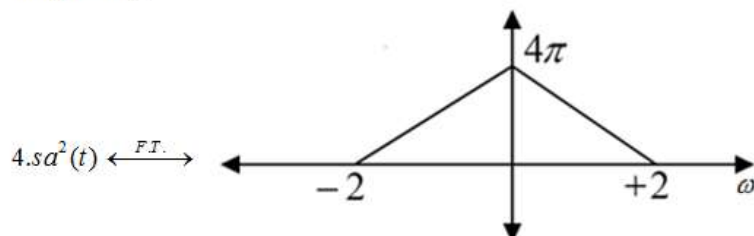


(51.) ANS: (a)

EXP:



Using duality;



(52.) ANS: (c) Both.

EXP: Any Symmetrical square wave is odd half wave symmetric, thus, all even harmonics are absent.

(53.) ANS: (c)

EXP:

$$f(t) \longleftrightarrow F(f)$$

$$f(t+3) \longleftrightarrow F(f) \cdot e^{j2\pi f \times 3}$$

$$f(-2+3) \longleftrightarrow \frac{1}{2} F(-f/2) e^{\frac{-j2\pi \times 3 f}{2}}$$

(54.) ANS: (a)

EXP:

$$\therefore f(t) \longleftrightarrow F(\omega)$$

$$f(t) \cdot e^{-j7t} \longleftrightarrow F(\omega+7)$$

$$\therefore \frac{1}{2} \cdot f(t/2) \cdot e^{-j3.5t} \longleftrightarrow F(2\omega+7)$$

(55.) ANS: (c)

EXP:

$$\therefore e^{-at} \cdot u(t) \longleftrightarrow \frac{1}{a+j\omega}$$

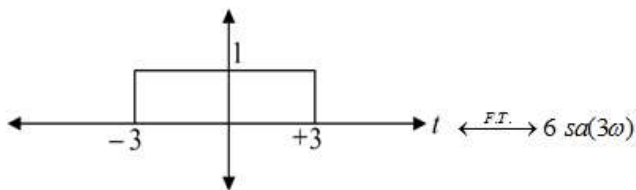
$$t \cdot e^{-at} \cdot u(t) \longleftrightarrow \frac{1}{(a+j\omega)^2}$$

$$t^2 \cdot e^{-at} \cdot u(t) \longleftrightarrow \frac{2}{(a+j\omega)^3}$$

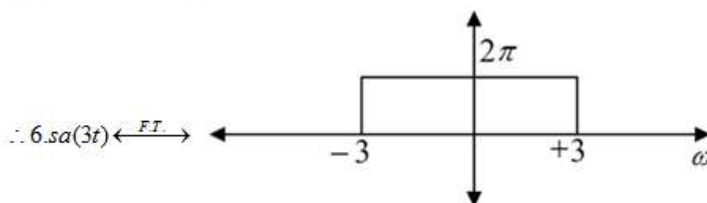
$$t^n \cdot e^{-at} \cdot u(t) \longleftrightarrow \frac{|n|}{(a+j\omega)^{n+1}}$$

(56.) ANS: (a)

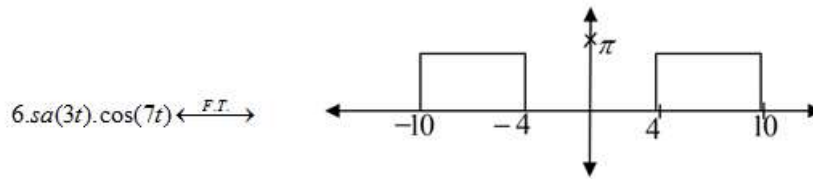
EXP:



Using duality, we have =



Using modulation theorem,



Using energy spectral density property, energy of $f(t) = \frac{1}{2\pi} \int_{-\infty}^{+\infty} |F(\omega)|^2 d\omega$

$$= \frac{1}{2\pi} \times 2 \times 6 \times \pi^2 = (6\pi) \text{ Joules}$$

(57.) ANS: (b)

EXP: Use time differentiation property i.e.

$$f(t) \longleftrightarrow F(\omega)$$

$$\frac{d^n f(t)}{dt^n} \longleftrightarrow (j\omega)^n F(\omega)$$

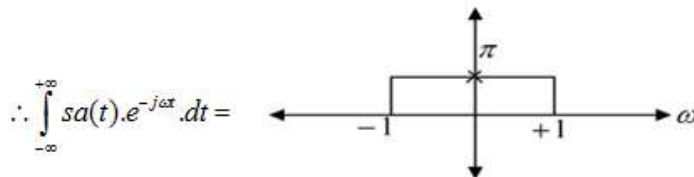
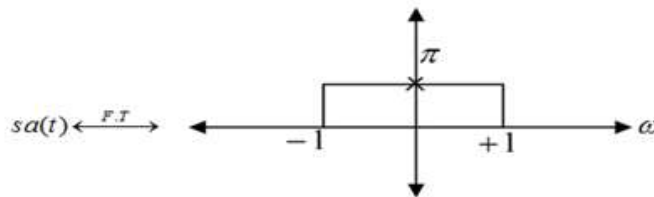
(58.) ANS: (b)

(59.) ANS: (c)

EXP: General Nature of Fourier Transfer.

(60.) ANS: (a)

EXP:



$$\text{Put } \omega = 0 \Rightarrow \int_{-\infty}^{+\infty} sa(t).dt = \pi$$

(61.) ANS: (b)

$$\text{EXP: } e^{-\pi t^2} \xleftrightarrow{F.T.} e^{-\pi f^2}$$

$$\Rightarrow \int_{-\infty}^{+\infty} e^{-\pi t^2} . e^{-j2\pi ft} . dt = e^{-\pi f^2}$$

$$\text{Put } f = 0$$

(62.) ANS: (a)

EXP: Taking Fourier transform on both sides =

$$y(\omega) [(j\omega)^2 + (j\omega) - 6] = X(\omega) [2j\omega + 1]$$

$$\Rightarrow H(\omega) = \frac{y(\omega)}{X(\omega)} = \frac{1}{3 + j\omega} - \frac{1}{2 - j\omega}$$

(63.) ANS: (c)

EXP:

$$\because \text{sgn}(t) \xrightarrow{F.T.} \frac{2}{j\omega}$$

$$\therefore \frac{2}{jt} \xrightarrow{F.T.} 2\pi \cdot \text{sgn}(-\omega)$$

$$\Rightarrow \frac{1}{\pi t} \longleftrightarrow j \cdot \text{sgn}(-\omega) = -j \text{sgn}(-\omega) = -j \cdot \text{sgn}(\omega) = j^3 \text{sgn}(\omega)$$

(64.) ANS: (c)

EXP: Hilbert's transform is a linear -90° phase shifter for positive frequency and $+90^\circ$ for negative frequency.

$$\therefore \sin(\omega_1 t) \xrightarrow{H.T.} \sin(\omega_1 t - \pi/2) = -\cos \omega_1 t$$

$$\therefore \cos(\omega_2 t) \xrightarrow{H.T.} \cos(\omega_2 t - \pi/2) = \sin \omega_2 t$$

(65.) ANS: (a)

EXP: Use modulation properties and 90° phase shifter transform

(66.) ANS: (a) Using standard Fourier transform pairs

EXP:

$$\because 1 \longleftrightarrow 2\pi \cdot \delta(\omega)$$

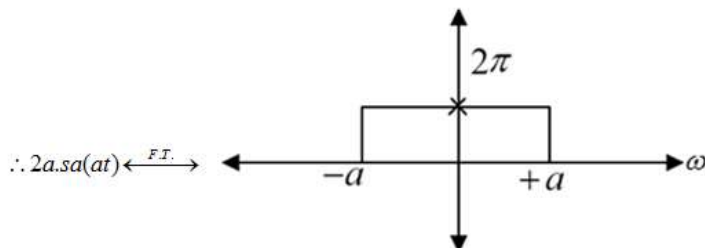
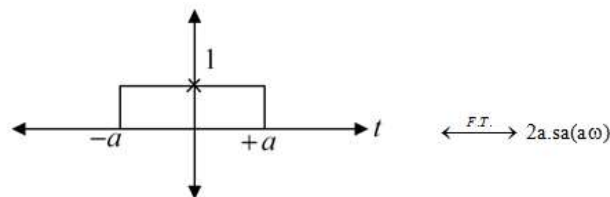
$$\therefore C_n \longleftrightarrow 2\pi \cdot C_n \cdot \delta(\omega)$$

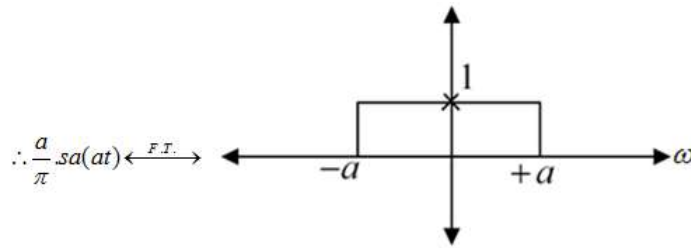
$$\therefore C_n \cdot e^{jn\omega_0 t} \longleftrightarrow 2\pi \cdot C_n \cdot \delta(\omega - n\omega_0)$$

$$\therefore \sum_{n=-\infty}^{+\infty} C_n \cdot e^{jn\omega_0 t} \longleftrightarrow 2\pi \sum_{n=-\infty}^{+\infty} C_n \cdot \delta(\omega - n\omega_0)$$

(67.) ANS: (b)

EXP:





$$\therefore x(t) = \frac{1}{\pi t} \cdot \sin(at) = \frac{a}{\pi} sa(at).$$

$$\therefore \text{energy} = \frac{1}{2\pi} \times 1 \times 2a \text{ Joules} = \left(\frac{a}{\pi} \right) \text{ joules}.$$

(68.) ANS: (b)

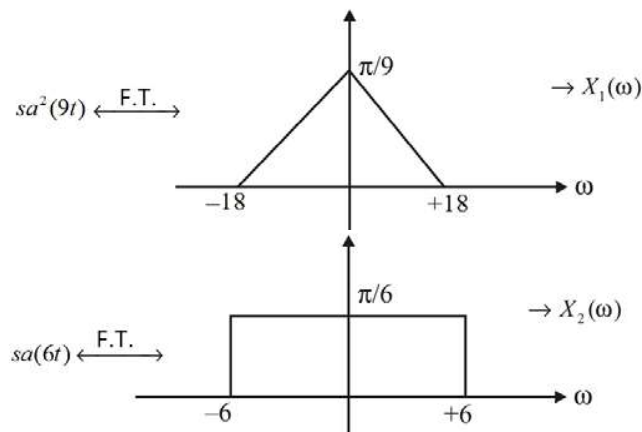
EXP:

$$\omega = 12 \text{ rad/sec}$$

$$2\pi f = 12 \quad f = \frac{12}{2\pi} = \frac{6}{\pi} \text{ Hz}$$

(69.) ANS: (b)

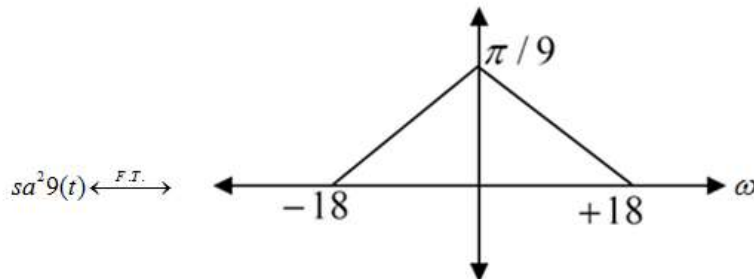
EXP: $x_1(t) = sa^2(9t) \quad x_2(t) = sa(6t)$



$$BW \text{ of } X_1(\omega) \cdot X_2(\omega) = 6 \text{ rad/sec}$$

(70.) ANS: (c)

EXP:



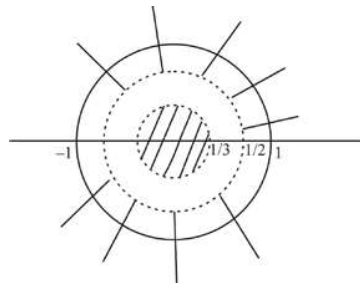
$$-a^n u(n) \longleftrightarrow \frac{z}{z-a}; |z| < |a|$$

(91.) ANS: (d)

EXP:

$$\left(\frac{1}{2}\right)^n u(n) \longleftrightarrow \frac{z}{1-\frac{1}{2}z}; |z| > \frac{1}{2}$$

$$\left(\frac{1}{3}\right)^n u(-n-1) \longleftrightarrow \frac{z}{1-\frac{1}{3}z}; |z| < \frac{1}{3}$$



No common ROC
Z.T. does not exist.

(92.) ANS: (a)

EXP:

$$\log\left(\frac{1}{1-a/z}\right) = -\log(1-a/z)$$

$$\therefore |a/z| < 1$$

$$\therefore -\log(1-a/z) = -\left(-\frac{a}{z} - \frac{a^2}{2z^2} - \frac{a^3}{3z^3} \dots\right)$$

$$= a.z^{-1} + \frac{a^2}{2}.z^{-2} + \frac{a^3}{3}.z^{-3} + \dots$$

(93.) ANS: (b)

EXP:

$$z^1 \longleftrightarrow \delta[n+1]$$

$$z^0 \longleftrightarrow \delta[n]$$

$$a^n u(n) \longleftrightarrow z/(z-a); |z| > |a|$$

$$-a^n u(-n-1) \longleftrightarrow z/(z-a); |z| > |a|$$

(94.) ANS: (c)

EXP:

$$\text{If } x(n) \xrightarrow{z} X(z)$$

$$\therefore n.x(n) \xrightarrow{z} -z \cdot \frac{dX(z)}{dz}$$

(95.) ANS: (a)

EXP:

If the signal is known to be causal then right-sided inverse transforms are chosen.

$$a^n u(n) \longleftrightarrow \frac{1}{1 - az^{-1}}$$

(96.) **ANS:** (c)

EXP:

If the signal is stable, then it is absolutely summable and has a DTFT. Hence stability and the existence of the DTFT are equivalent conditions. In both cases, the ROC includes the unit circle in the z plane, $|z| = 1$.

If a pole is inside the unit circle, then the right-sided inverse z transform is chosen, if a pole is outside the unit circle, then the left sided inverse z -transform is chosen.

(97.) **ANS:** (a)

EXP: Taking unilateral Z - transform on both sides of the system equation =

$$Y(z) - \frac{1}{2} [z^{-1} Y(z) + Y(-1)] = X(z)$$

$$\Rightarrow Y(z) = \frac{(2z - 1/3)z}{(z - 1/2)(z - 1/3)}$$

Also, unilateral Z -transform of $Y(n - 2) = z^{-2} Y(z) + z^{-1} y(-1) + y(-2)$.

Just like unilateral Laplace transform with initial conditions.

(98.) **ANS:** (b)

EXP: Initial value = $\lim_{z \rightarrow \infty} X(z)$

Final value = $\lim_{z \rightarrow 1} (1 - z^{-1}) X(z)$

But caution is that while applying final value theorem all the poles must lie within the unit circle, otherwise the final value is unbounded.

(99.) **ANS:** (c)

EXP: For a causal and stable system, R.O.C. must be outwards and include the unit circle, Thus,

R.O.C is $|z| > 1/3$

(100.) **ANS:** (c)

$$\text{EXP: } C_k = \frac{1}{N_0} \sum_{n=0}^{N_0-1} x(n) e^{-j.k.\frac{2\pi}{N_0}.n}$$

Here, $N_0 = 4$

$$\therefore C_k = \frac{1}{4} \sum_{n=0}^3 x(n) e^{-jk\frac{\pi}{2}n}$$

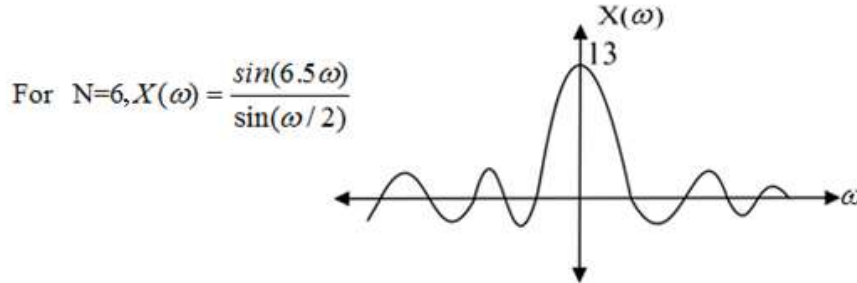
(101.) **ANS:** (a)

EXP: D.T.F.T. is defined only when the signal is absolutely summable, which is possible when $|a| < 1$ and $|b| > 1$

(102.) **ANS:** (b)

(103.) **ANS:** (c)

$$\text{EXP: } X(\omega) = \sum_{n=-\infty}^{+\infty} x(n) \cdot e^{-j\omega n} = \frac{\sin(\omega(N+1/2))}{\sin(\omega/2)}$$



Max. Value at $\omega = 0$, and take limit $\omega \rightarrow 0$, value = $\frac{6.5}{0.5} = 13$

(104.) ANS: (c)

(105.) ANS: (b)

$$\begin{aligned} \text{EXP: } x(n) &= \frac{1}{2\pi} \int_{-\pi}^{+\pi} X(\omega) \cdot e^{j\omega n} \cdot d\omega \\ &= \frac{1}{2n} \int_{-\pi/4}^{+\pi/4} 1 \cdot e^{j\omega n} \cdot d\omega = \frac{\sin(n\pi/4)}{n\pi} \end{aligned}$$

$\therefore$ the input is periodic with $N_0 = 5$, so it will have harmonics like $0, 2\pi/5, 4\pi/5$, etc. But $X(\omega)$ will pass only the frequencies upto $\pi/4$ rad/s. Thus, only d.c. will be passed with gain = 1.

$$\therefore C_0 = \frac{1}{N_0} \sum_{n=0}^4 x(n) = 6/5.$$

$\therefore$ Output = $6/5$.

(106.) ANS: (a)

EXP:

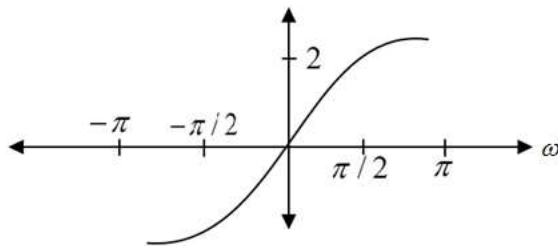
$$y(n) = x(n) - x(n-1]$$

$$\therefore Y(Z) = X(Z) [1 - z^{-1}]$$

$$\therefore H(j\omega) = H(Z) \Big|_{Z=e^{j\omega}} = 1 - e^{-j\omega}$$

$$\begin{aligned} \therefore |H(j\omega)| &= \sqrt{(1 - \cos \omega)^2 + (\sin \omega)^2} \\ &= 2 \cdot \sin(\omega/2) \end{aligned}$$

$$|H(\omega)|$$



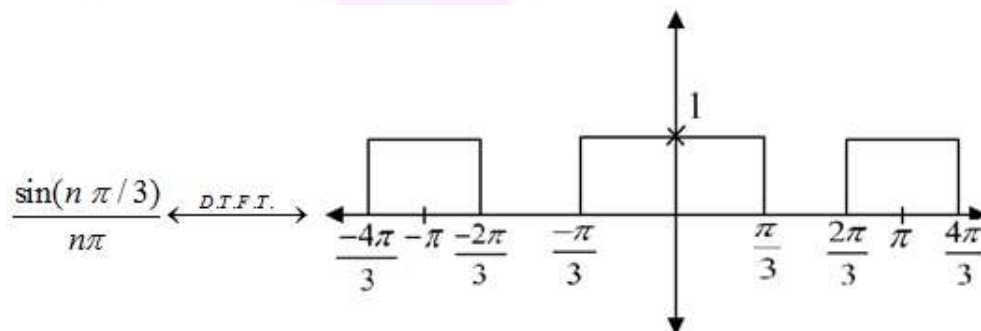
So, it will pass only the high frequencies.

(107.) ANS: (c)

$$\text{EXP: } |H(\omega)| = \frac{\sqrt{k^2 + 1 + 2k \cos \omega}}{\sqrt{k^2 + 1 + 2k \cos \omega}} = 1$$

Thus, an all pass system.

(108.) ANS: (b)



$$\therefore \sum_{n=-\infty}^{+\infty} \frac{\sin(n\pi/3).e^{-j\omega n}}{n\pi} = H(\omega). \text{ as shown above}$$

Put $\omega = 0$

$$\Rightarrow \sum_{n=-\infty}^{+\infty} \frac{\sin(n\pi/3)}{n\pi} = H(0) = 1$$

$$\therefore \sum_{n=-\infty}^{+\infty} \frac{\sin(n\pi/3)}{n} = 1 \times \pi = \pi$$

(109.) ANS: (b)

EXP: For an N- Point DFT,

$$F(k) = F^*(N - k)$$

$$\therefore X = F(3) = F^*(5) = -10 - j6$$

$$\text{Total energy} = \frac{1}{N} \sum_{k=0}^{N-1} |F(k)|^2$$

$$= \frac{497}{8} J = 62.125 J$$

(110.) ANS: (b)

(111.) ANS: (b)

(112.) ANS: (a)

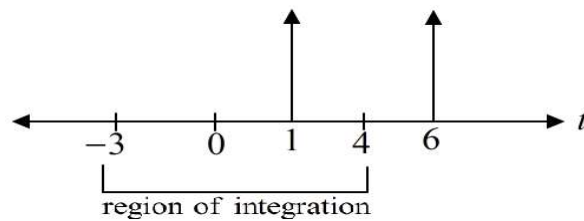
(113.) ANS: (c)

(114.) ANS: (b)

EXP:

$$t^2 - 7t + 6 = 0$$

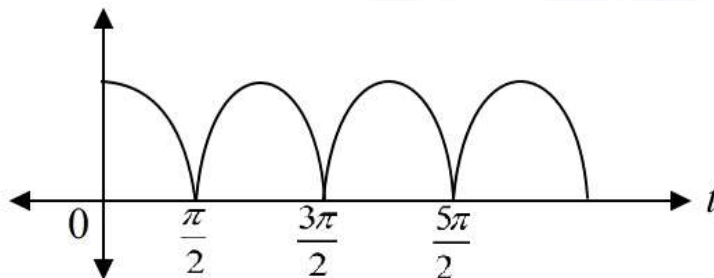
$$\Rightarrow t = 6, 1$$



(115.) ANS: (b)

EXP: For stability; $\int_{-\infty}^{+\infty} |h(t)| \cdot dt < \infty$

Graph for $|\cos t \cdot u(t)|$



Thus, integration becomes ∞ .