GATE - 1994

Electronics and Communication Engineering

1.1 The Laplace transform of a unit ramp function starting at $t = a$, is

(*a*) $\frac{1}{(s+a)^2}$ (*b*) $\frac{e^{-as}}{(s+a)^2}$

(*c*) $\frac{e^{-as}}{s^2}$ (*d*) $\frac{a}{s^2}$

1.2 The Fourice Series of a odd periodic function, contains only

(*a*) odd harmonics (*b*) even harmonics

(*c*) cosine terms (*d*) sine terms

1.3 A series LCR circuit consisting of $R = 10\ \Omega$, $|X_L| = 20\ \Omega$ and $|X_C| = 20\ \Omega$, is connected across an a . c. supply of 200 V rms. The rms voltage across the capacitor is

(*a*) $200\ \angle -90°$ V (*b*) $200\ \angle +90°$ V

(c) $400\ \angle -90°$ V (*d*) $400\ \angle -90°$ V

1.4 A ramp voltage, $v(t) = 100$ volts, is applied to an RC differentiating circuit with $R = 5k\ \Omega$ and $C = 4\ \mu F$. The maximum output voltage is

(*a*) 0.2 volts (*b*) 2.0 volts

(*c*) 10.0 volts (*d*) 50.0 volts

1.5 The 3 – *d*B bandwidth of a typical second-order system with the transfer function

$$\frac{C(s)}{R(s)} = \frac{w_n^2}{s^2\ t + 2\,x\,w_n\,s + w_n^2}$$ is given by

(*a*) $\omega_n = \sqrt{1 - 2\,\xi^2}$

(*b*) $\omega_n = \sqrt{1 - 2\,\xi^2) + \sqrt{\xi^4 - \xi^2 + 1}}$

(*c*) $\omega_n = \sqrt{1 - 2\,\xi^2) + \sqrt{4\,\xi^4 - 4\,\xi^2 + 2}}$

(*d*) $\omega_n = \sqrt{1 - 2\,\xi^2) + \sqrt{4\,\xi^4 - 4\,\xi^2 + 2}}$

1.6 If the open-loop transfer function is a ratio of a numerator polynomial of degree '*m*' and a denominator polynomial of degree '*n*', then the integer (*n–m*) represents the number of

(*a*) breakaway points (*b*) unstable poles

(c) separate root loci (*d*) asymtotes

1.7 A small concentration of minority carries is injected into a homogeneous semiconductor crystal at one point. An electric field of 10 V.cm is applied across the crystal and this moves the minority carriers a distance of 1 cm is 20 μ sec. The mobility (in cm^2/volt. sec) will be

(*a*) 1,000 (*b*) 2,000

(*c*) 5,000 (*d*) 500,000

1.8 The threshold voltage of an n channel MOSFET can be increased by

(*a*) increasing the channel dopant concentration

(*a*) reducing the channel dopant concentration

(c) reducing the gate-oxide thickness

(*d*) reducing the channel length

1.9 A class - A transformer coupled, transistor power amplifier is required to deliver a power output of 10 watts. The maximum power rating of the transistor should not be less than

(*a*) 5 W (*b*) 10 W

(*c*) 20 W (*d*) 40 W

1.10 Data can be changed from spatial code to temporal code and vice-versa by using

(*a*) ADCs and DACs

(*b*) shift-registers

(*c*) synchronous counters

(*d*) timers

1.11 The output of a logic gate is '1' when all its inputs are at logic '0'. Then gate is either

(*a*) a NAND or an EX-OR gate

(*b*) a NOR or an EX-NOR gate

(*c*) an OR or an EX-NOR gate

(*d*) an AND or an EX-OR gate

1.12 A PLA can be used

(*a*) as a microprocessor

(*b*) as a dynamic memory

(*c*) to realise a sequential logic

(*d*) to realise a combinational logic

1.13 A dynamic RAM consists of

(*a*) 6 transistors

(*b*) 2 transistors and 2 capacitors

(*c*) 1 transistor and 1 capacitor

(*d*) 2 capacitors only

1.14 $v(t) = 5$ [cos(106 πt) – sin (103 πt) × sin (106 πt) represents

(*a*) DSB suppressed carrier signal

(*b*) AM signal

(*c*) SSB upper sideband signal

(*d*) Narrow band FM signal

1.15 Increased pulse-width in the flat-top sampling, leads to

(*a*) attenuation of high frequencies in reproduction

(*b*) attenuation of low frequencies in reproduction

(*c*) greater aliasing errors in reproduction

(*d*) no harmful effects in reproduction

1.16 Medium wave radio signals may be received at far off distances at night because
(*a*) radio waves travel faster at night
(*b*) ground wave attenuation is low at night
(*c*) the sky wave is stronger at night
(*d*) their is no fading at night

1.17 For a short wave radio link between two stations via the ionosphere, the ratio of the maximum usable frequency to the critical frequency
(*a*) is always less than 1
(*b*) is always greater than 1
(*c*) may be less than or more than 1 depending on the distance between the two stations
(*d*) does not depend on the distance between the two stations

1.18 A plane eelctromagnetic wave travelling along + z – direction, has its electric field given by $E_x = 2\cos(*t)$ and $E_y = 2\cos(*t + 90°)$.

The wave is
(*a*) linearly polarised
(*b*) right circularly polarised
(*c*) left circularly polarised
(*d*) elliptically polarised

1.19 For a dipole antenna
(*a*) the radiation intensity is maximum along the normal to the dipole axis
(*b*) the current distribution along its length is uniform irrespective of the length
(*c*) the effective length equals its physical length
(*d*) the input impedance is independent of the location of the feed-point

2. In each of the following questions (2.1 - 2.20) fill in the blanks appropriately

2.1 $\oint_c \vec{A}\cdot d\vec{t} = \int_s - - - .\, d\vec{s}$

2.2 The rank of an $(m \times n)$ matrix $(m < n)$ cannot be more than ____________.

2.3 The condition that a z-port network is reciprocal, can be expressed in terms of its ABCD parameters as ____________.

2.4 A generator of internal impedance, Z_G, deliver maximum power to a load impedance, Z_L, only if Z_L = ____________.

2.5 The open loop frequency response of a system at two particular frequencies are given by : $1.2 \angle 180°$ and $1.0 \angle -190°$.

The closed loop unity feed back control is then ____________.

2.6 The poles of a continuous time oscillators are ____________.

2.7 The forward dynamic resistance of a junction diode varies ____________ as the forward current.

2.8 The transit time of the current carriers through the channel of an FET decides its ____________ chracteristics.

2.9 In order to reduce the harmonic distortion in an amplifier, its dynamic range has to be ____________.

2.10 A common emitter transistor amplifier has a cullector corrent of 1.0 mA when its base current is 25 μA at the room temperature. It's input resistance is approximately equal to ____________.

2.11 A pulse having a rise time of 40n sec is displayed on a CRO of 12 MHz bandwidth. The rise time of the pulse as observed on the CRO would be approximately equal to ____________.

2.12 For the 2N 338 transistor, the manufacturer specifics P_{max} = 100 mW at 25°C free-air temperature and the maximum Junction temperature, T_{jmax}, = 125°C. Its thermal resistance is ____________.

2.13 The frequency compensation is used in op-amps to increase its ____________.

2.14 A 2 μ sec pulse can be strecthed into a 10 m sec pulse by using a ____________circuit.

2.15 Synchronous counters are ____________ than the ripple counters.

2.16 A ring oscillator consisting of 5 inverters is runnig at a frequency of 1.0 MHz. The propagation delay per gate is ____________ *n* sec.

2.17 A 10 MHz carrier is frequency modulated by a sinusoidal signal of 500 hz, the maximum frequency deviation being 50 kHz. The bandwidth required, as given by the Carson's rule is ____________.

2.18 The bandwidth required for the transmission of a PCM signal increases by a factor of ____________ when the number of quantization levels is increased from 4 to 64.

2.19 A load impedance, (200 + jo) Ω is to be matched to a 50 Ω lossless transimssion line by using a aquarter wave line transformer (QWT). The characteristic impedance of the QWT required is ____________.

2.20 The interior of a $\frac{20}{3}$ cm × $\frac{20}{4}$ cm rectangular wave guide is completely filled witha dielectric of $\varepsilon_r = 4$. Waves of free space wave-lengths shorter than ____________ can be propagated in the TE_{11} mode.

3.1 $Z(s) = \frac{5}{s^2 + 4}$ represents the input impedance of a network.

3.2 Tachometer feedback in *a d.c.* position control systme enhances stability.

3.3 If G (*s*) is a stable transfer function, then $F(s) = \frac{1}{G(s)}$ is always a stable transfer function.

3.4 A *p*-type silicon sample has a higher conductivity compared to an *n*-type sample having the same dopant concentration.

3.5 Channel current is reduced on application of a more positive voltage to the gate of a depletion mode n-channel MOSFET.

3.6 The look-ahead carry adder is a parallel carry adder where all sum digits are generated directly from the input digits.

3.7 In the output stage of a standard TTL, have a diode between the emitter of the pull-up transistor and the collector of the pull-down transistor. The purpose of this diode is to isolate the output node from the power supply V_{α}.

3.8 Pulse-width modulated signals are immune to noise since their amplitude is constant.

3.9 Noise figure of an amplifier is always greater than 1.

3.10 If a pure resistance load, when connected to a lossless 75-ohm line, produces a VSWR of 3 on the line, then the load impedance can only be 25 ohms.

4. In each of the following questions (4.1 - 4.8) match each of the items A, B and C with an appropriate it m from 1, 2, 3, 4 and 5.

4.1 (*A*) $a_1 \frac{d^2y}{dx^2} + a_2\, y \frac{dy}{dx} + a_3\, y = a_4$

(*B*) $a_1 \frac{d^3y}{dx^3} + a_2\, y = a_3$

(C) $a_1 \frac{d^2y}{dx^2} + a_2\, x \frac{dy}{dx} + a_3 x^2\, y = 0$

(1) Non-liner differential equation
(2) Linear differential equation with constant coefficients
(3) Linear homogeneous differential equation
(4) Non-linear homogeneous differential equation
(5) Non-linear first order differential equation

4.2. The response of an LCR circuit to a **step input is** If the transfer function has

(1) poles on the negative real axis	(*A*) over damped
(2) poles on the imaginary axis	(*B*) critically damped
(3) multiple poles on the positive realaxis	(*C*) oscillatory
(4) poles on the positive real axis	
(5) multiple poles on the negative real axis	

4.3 (*A*) Very low response at very high frequencies
(*B*) Over shoot
(C) Synchro-control transformer output
(1) Low-pass systems
(2) Velocity damping
(3) Natural frequency
(4) Phase-sensitive modulation
(5) Damping ratio

4.4 (*A*) The current gain of a BJT will be increased if
(*B*) The current gain of a BJT will be reduced if
(C) The break-down voltage of a BJT will be reduced if
(1) The collector doping concentration is increased.
(2) The base width is reduced.
(3) The emitter doping concentration to base doping concentration ratio is reduced.
(4) The base doping concentration is increased keeping the ratio of the emitter doping concentration to base doping concentration, constant.
(5) The collector doping concentration is reduced.

4.5

(*A*) Hartley	(1) Low frequency oscillator
(*B*) Wien-bridge	(2) High frequency oscillator
(C) Crystal	(3) Stable frequency oscillator
	(4) Relaxation frequency oscillator
	(5) Negative resistance oscillator

4.6 Type of ADC

(*A*) Successive aproximation	(1) 1
(*B*) Dual-slope	(2) 8
(C) Parallel Comparator	(3) 16
	(4) 256
	(5) 512

Maximum conversion for 8 bit ADC in clock cycles.

4.7

(*a*) Single side band	(1) Envelope detector
(*b*) Amplitude modulation	(2) Integrate and dump
(*c*) Binary phase-shift keying	(3) Hilbert transform
	(4) Ratio detector
	(5) Phase-locked loop

4.8 (A) $\vec{\nabla} \times \vec{H} = \vec{J}$

(B) $\int_c \vec{E} \cdot \vec{a}_l = -\frac{d}{f} \int_s \vec{B} \cdot \vec{ds}$

(C) $\vec{\nabla}\ \vec{J} = -\frac{\partial_p}{\partial_t}$

(1) Continuity equation

(2) Faraday's law

(3) Ampere's Law

(4) Gauss's law

(5) Biot-Savart law

ANSWERS

1. 1 (*c*)	**1. 2** (*d*)	**1. 3** (*d*)	**1. 4** (*b*)	**1. 5** (*c*)	**1. 6** (*d*)	**1. 7** (*c*)	**1. 8** (*b*)	**1. 9** (*c*)	**1. 10** (*a*)
1. 11 (*b*)	**1. 12** (*d*)	**1. 13** (*c*)	**1. 14** (*d*)	**1.15** (*a*)	**1. 16** (*c*)	**1. 17** (*b*)	**1. 18** (*c*)	**1. 19** (*a*)	

EXPLANATIONS

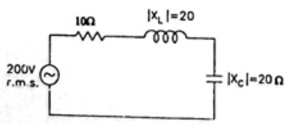
1.3 Voltage across the capacitor

$$= \frac{200}{\sqrt{R^2 + (X_L - X_C)^2}} \times (-jX_C)$$

$$= \frac{200}{\sqrt{100 + (20-20)^2}} \times (-j20)$$

$$= -j\,400$$

$$= 400 \angle -90 \text{ V}$$



1.4 In the Laplace domain,

$$V_o(s) = \frac{V_i(s)}{R + \frac{1}{Cs}} \times R$$

$$= \frac{V_i(s)\,RCs}{RCs + 1}$$

$$V_i(t) = 100\,t\,u(t)$$

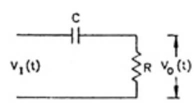
and $\quad V_i(s) = \frac{100}{s^2}$

Hence, $V_o(s) = \frac{100}{s^2}\left[\frac{5 \times 10^3 \times 10^{-6} s}{5 \times 10^3 \times 4 \times 10^{-6} s + 1}\right]$

$$= \frac{2}{s\left(2 \times 10^{-2} s + 1\right)} \approx \frac{2}{s}$$

$$V_o(t) = 2\,u(t)$$

$\therefore$ Maximum voltage = 2 V



1.5 $\quad H(s) = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2}$

$$H(j\omega) = \frac{\omega_n^2}{-\omega^2 + 2\zeta\omega_n j\omega + \omega_n^2}$$

$$|H(jw)| = \frac{\omega_n^2}{\sqrt{\left(\omega_n^2 - \omega^2\right)^2 + (2\zeta w_n \omega)^2}}$$

$$|H(j0)| = 1$$

If ω_c is the 3 – dB frequency, then

$$[H(j\omega_c)] = \frac{\omega_n^2}{\sqrt{\left(\omega_n^2 - \omega_c^2\right)^2 + (2\zeta w_n \omega_c)^2}}$$

$$= 0.707$$