ESE 2024 Prelims Solutions

Electronics & Telecom Engineering

Set-B

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Electronics & Telecom Engg. Paper Analysis of ESE 2024 Preliminary Examination		
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UPSC ESE Prelims 2024

Electronics & Telecom. Engg. analysis

by MADE EASY faculties

1. The mean time between failures and the mean failure rate if 100 faults were recorded for 300 transducers of a system during 1.5 years, the mean down time being 1 day, are respectively

(a) 2.245 years and 0.123 per year
(b) 4.497 years and 0.222 per year
(c) 6.787 years and 0.436 per year
(d) 8.525 years and 0.662 per year

Ans. (b)

$$\text{Mean down time} = 1 \text{ day} \Rightarrow \frac{1}{365} \text{ year}$$

100 Faults, 300 transducer and 1.5 year

$$\text{MTBF} = \frac{300 \times 1.5 - 100 \times \frac{1}{365}}{100} = 4.497 \text{ year}$$

$$\text{Mean failure rate } \lambda = \frac{1}{4.497} = 0.222 \text{ per year}$$

End of Solution

2. A potentiometer is used to measure the displacement of a hydraulic ram. The potentiometer is 25 cm long, has a total resistance of 2500 ohms and is operating at 4 W with a voltage source. If it has linear resistance-displacement characteristics, then the sensitivity of the potentiometer (without loading effect) is

(a) 2 V/cm
(b) 4 V/cm
(c) 8 V/cm
(d) 12 V/cm

Ans. (b)

Given that $\Rightarrow$ Potentiometer

$$l = 25 \text{ cm}, \quad R = 2500\ \Omega, \quad P = 4 \text{ W}$$

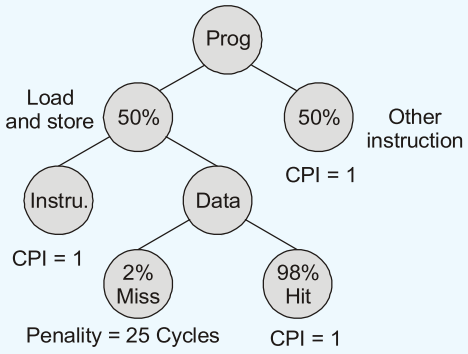
$$\text{Sensitivity}_{POT} = \frac{V}{l} = \frac{100 \text{ Volt}}{25 \text{ cm}} = 4 \text{ Volt/cm}$$

End of Solution

3. Assume we have a computer where the clocks per instruction (CPI) is 1.0 when all memory accesses hit in the cache. The only data accesses are loads and stores, and these total 50% of the instructions. If the miss penalty is 25 clock cycles and the miss rate is 2%, how much faster would the computer be if all instructions were cache hits?

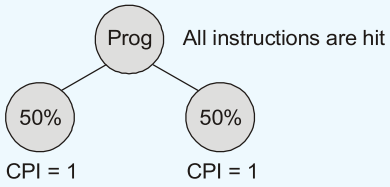
(a) 2.75 times faster
(b) 1.75 times faster
(c) 3.75 times faster
(d) 4.75 times faster

Ans. (b)



$$\text{Total} : \frac{1 + 25}{26}$$

$$ET = (0.5 \times 1) + (0.5 \times 0.02 \times 26) + (0.5 \times 0.98 \times 1) + (0.5 \times 1)$$
$$= 1.75$$



$$ET = 1$$

$$\therefore \quad S = \frac{1.75}{1} = 1.75$$

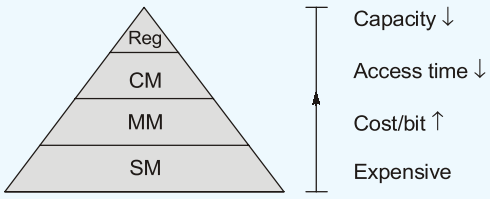
x

End of Solution

4. Which one of the following is not correct when one goes down a memory hierarchy?
(a) Decreasing cost per bit
(b) Increasing capacity
(c) Decreasing access time
(d) Decreasing frequency of access of the memory by the processor

Ans. (c)

Bottom to top approach of a memory hierarchy access time decreases.
So, top to bottom, access time increases.



End of Solution

5. Which one of the following is the disadvantage of the software pole?
(a) Timing, and it can be rectified by daisy chain.
(b) Delay, and it can be rectified by vectored interrupt.
(c) Longest routing, and it can be rectified by multiple interrupt lines.
(d) Response time, and it can be rectified by interrupt controller.

Ans. (d)
Response time and it can be reached by interrupt controller (8259).

End of Solution

6. Which one of the following is not related to the CISC architecture?
(a) Typically 100 - 250 instructions
(b) 5-20 addressing modes
(c) Fixed length instruction formats
(d) Instructions that manipulate operands in memory

Ans. (c)
- RISC CPU supports fixed length instructions.
- CISC CPU supports variable length instructions.

End of Solution

7. Which one of the following steps is not correct for an asynchronous data transfer?
(a) When the character is not being sent, the line is kept in the 0 state.
(b) The initiation of a character of a transmission is detected from the start bit which is always zero.
(c) The character bit always follows the start bit.
(d) After the last bit of the character is transmitted, the stop bit is detected.

Ans. (a)
Actually, the line state is 1 (high) when the is no data.

End of Solution

8. In deadlock condition, at least one resource must be held in a non-shareable mode; that is, only one process at a time can use the resource. If another process requests that resource, the requesting process must be delayed until the resource has been released. This is called
(a) Circular wait
(b) Mutual exclusion
(c) Hold and wait
(d) No preemption

Ans. (b)
Mutual exclusion prevents multiple threads form accessing the same shared resource simultaneously.

End of Solution

9. Which one of the following statements is not correct for a buffer?
(a) Buffering is to cope with a speed mismatch between the producer and consumer of a data stream.
(b) Buffering is to adapt between devices that have different data-transfer sizes.
(c) Buffering is to support copy semantics for application I/O.
(d) Buffering holds a copy on faster storage of an item that resides elsewhere.

Ans. (c)
Nowhere linked with semantics and it is used for speed mismatch between devices.

End of Solution

10. In a program, the following declaration : float number1, number2, sum, average; is represented as
(a) variables
(b) floating numbers
(c) input data
(d) decimal numbers

Ans. (a)
Variable is declared in the program with the following syntax.
<data type> variable name.

End of Solution

11. Which one of the following is not correct about Rambus DRAM?
(a) The special DRAM bus delivers address and control information using an asynchronous block oriented protocol.
(b) Data rate is 1.6 GBps.
(c) Its operation can be controlled by the explicit RAS, CAS, R/W & CE signals.
(d) It sends data to the controller synchronously to the clock to master, and the controller sends data to an RDRAM synchronously with the clock signal in opposite direction.

Ans. (a)
RDRAM is synchronous type but it is given as asynchronous block oriented protocol which is not correct.

End of Solution

12. Non-uniform memory access belongs to
(a) SISD
(b) SIMD
(c) MISD
(d) MIMD

Ans. (d)
Non-uniform Memory Access (NUMA) is a method of configuring a cluster of microprocessors in a multiprocessing system so they can share memory locally. This idea is used to improve the systems performance.

End of Solution

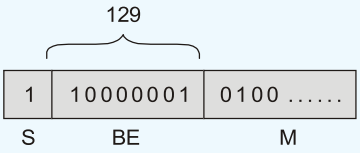
13. What single-precision number does the following 32-bit word represent?

11000000101000000000000000000000

(a) –2 (b) –4

(c) –5 (d) –7

Ans. (c)



Bias = 127

$$\text{Value} = (-1)^s (1 \cdot M) * 2^{\text{BE-Bias}}$$

$$= (-1)^1 (1.0100 \ldots) * 2^{129 - 127}$$

$$= -1.01000 \ldots * 2^2 = -5$$

End of Solution

14. A better measure of memory-hierarchy performance is the average time to access memory. This can be represented as

(a) Average memory access time = Hit time + 2(Miss rate x Miss penalty)

(b) Average memory access time = Hit time + Miss rate x Miss penalty

(c) Average memory access time = 2 Hit time + Miss rate x Miss penalty

(d) Average memory access time = Hit time + (Miss rate x Miss penalty)/2

Ans. (b)

$$T_{avg} = \text{Hit time} + (\text{Miss rate} \times \text{Miss penalty})$$

OR

$$T_{avg} = H_C T_C + (1 - H_C)(T_M + T_C)$$

End of Solution

15. Which of the following are used to make a decision that determines the program flow, based on ALU results or the contents of register?

(a) BCD codes (b) Grey codes

(c) Condition codes (d) Excess-3 codes

Ans. (c)

Condition codes i.e. flag register/status word.

End of Solution

16. If the open loop transfer function of a servo system with unity feedback is $G(s) = \dfrac{10}{s(1+0.1s)}$, then the acceleration, velocity and position error constants are respectively

(a) ∞, 0, 1 (b) 0, 1, ∞

(c) 0, 10, ∞ (d) ∞, 1, 10

Ans. (c)

We have,

$$\text{OLTF as } G(s)\,H(s) = \frac{10}{s(1+0.1s)}$$

Position error constant,

$$\lim_{s\to 0} G(s)H(s) = \lim_{s\to 0} \frac{10}{s(1+0.15)} = \infty$$

Velocity, error constant,

$$\lim_{s\to 0} 6sG(s)H(s) = \lim_{s\to 0} \frac{s\times 10}{s+s(1+0.1s)} = 10$$

Acceleration error constant,

$$\lim_{s\to 0} s^2G(s)H(s) = \lim_{s\to 0} \frac{s^2\times 10}{s(1+0.1s)} = 0$$

Hence, option (c) is correct.

End of Solution

17. A feedback system has an open loop transfer function of $G(s)H(s) = \dfrac{K(1-s)}{s(s^2+5s+9)}$. The maximum value of K for the closed loop system to be stable is

(a) 3.5 (b) 4.8

(c) 6.5 (d) 7.5

Ans. (c, d)

We have, characteristic equation as

$$1 + G(s)H(s) = 0$$

$$s^3 + 5s^2 + 9s + K - Ks = 0$$

$$s3 + 5s^2 + s(9 - K) + K = 0$$

s^3	1	$9-K$
s^2	5	K
s^1	$\dfrac{45-5K-K}{5}$	
s^0	K	

45 . 6 K

7.5 . K

Hence, $0 < K < 7.5$

End of Solution

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18. A unity feedback system is characterized by an open-loop transfer function $G(s)=\dfrac{K}{s(s+10)}$. If the damping ratio is 0.5, then the time to peak overshoot for the unit step input is

(a) 0.125 sec (b) 0.175 sec
(c) 0.254 sec (d) 0.363 sec

Ans. (d)

We have, $G(s) = \dfrac{K}{s(s+10)}$; $\xi = 0.5$

Characteristic equation,

$$s^2 + 105 + K = 0$$
$$2\xi\omega_n = 10$$
$$\omega_n = 10 \text{ rad/sec}$$

$$\text{Peak overshoot} = \frac{n\pi}{\omega_d} = \frac{\pi}{10\sqrt{1-(0.5)^2}}$$ $n = 1$ for first peak overshoot

$$t_p = 0.362 \text{ sec}$$

Hence, option (d) is correct.

End of Solution

19. Consider the following statements:

1. Rise time for the underdamped system is the time required for the response to rise from 5% to 95% of its final value.
2. The amount of maximum overshoot directly indicates the relative stability of the system.
3. Settling time is the time required for the response to reach and maintain within a specified tolerance band, i.e. either 3% or 6% of the final value.

Which of the above statements are not correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (a)

End of Solution

20. Consider the following statements :

1. In PD controllers, derivative action provides the counterbalancing effect of rapidly changing disturbances, which does not take care of the offset.
2. In PI controllers, proportionality constant provides simplicity, reliability, directness, etc.
3. PI systems have some oscillatory effect.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (c)

End of Solution

21. The crystal structure of Titanium metal is
(a) Face-Centered Cubic
(b) Body-Centered Cubic
(c) Hexagonal Close-Packed
(d) Having randomly organized unit cells

Ans. (c)
The HCP metals include cadmium, magnetism, titanium and zinc.

End of Solution

22. Manganese oxide (MnO) is a
(a) Ferrimagnetic material
(b) Antiferromagnetic material
(c) Ferromagnetic material
(d) Paramagnetic material

Ans. (b)
MnO is antiferromagnetic material.

End of Solution

23. Consider the following statements regarding measurement system:
1. In the case of suspended coil permanent magnet moving coil (PMMC) instruments, the release of internal strain of the suspension wire causes drift of the zero-setting.
2. Creep of a transducer is usually defined as the change of output with time following a step increase in the input from one value to another.
3. Even above the threshold input, an instrument needs a minimum increment in the input to produce a perceptible output. This minimum necessary increment is called the resolution of the instrument.

Which of the above statements is/are correct?
(a) 1 only
(b) 1 and 2 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans. (d)

End of Solution

24. Dead-zone in a pyrometer is 0.125% of the span. The instrument is calibrated from 800°C to 1800°C. What is the value of temperature below which no change can be detected?
(a) 0.125°C
(b) 1°C
(c) 1.25°C
(d) 2.25°C

Ans. (c)
Dead-zone of pyrometer = 0.125% of span

$$\text{Span} = 1800°C - 800°C = 1000°C$$

$$\text{Dead zone} = \frac{0.125}{100} \times 1000°C = 1.25C°$$

End of Solution

25. Consider the following statements regarding measurement system:
1. If a known voltage of 200 V is being measured by a voltmeter and the successive readings are 204, 205, 203, 203 and 205 volts, then the accuracy is about 1.25%.
2. If 'a' denotes accuracy, 'p' denotes the precision and 'c' denotes the calibration error, then a = p + c.
3. Though the instrument is showing the correct value, the precision of the measurement depends upon the number of significant figures to which the observer can read the value.

Which of the above statements is/are not correct?
(a) 1 only (b) 2 only
(c) 1 and 2 (d) 2 and 3

Ans. (c)

1. Know voltage = V_{True} = 200 Volts
Successive readings are ⇒ 204, 205, 203, 203 and 2.5

$$V_{measured} = \frac{204 + 205 + 203 + 203 + 205}{5} = 204 \Rightarrow V_{measurement}$$

$$\%\,Error = \frac{V_M - V_T}{V_T} = \frac{204 - 200}{200} \times 100 = \frac{4}{200} \times 100 = 2\%$$

2. Accuracy = Precision ± Condition
$a = P \pm C$

End of Solution

26. Consider the following statements regarding wet and dry bulb Hygrometer:
1. Ubiquitous hygrometer consists of two mercury-in-glass thermometers, the bulb of one of which is covered with a wick or muslin.
2. Wick or muslin, in turn, is always kept moist by dipping both its ends into water contained in a small vessel.
3. Continuous evaporation of water from the surface of the wet bulb keeps its temperature lower than that of the dry bulb.

Which of the above statements is/are not correct?
(a) 1 only (b) 2 only
(c) 1 and 2 (d) 2 and 3

Ans. (b)

End of Solution

27. Consider the following statements regarding capacitive hygrometer:
1. It is suitable for measuring moisture content in many gases including hydrocarbons.
2. Being a capacitor, it can be easily incorporated in microprocessor-based electronic instrumentation.
3. It cannot be used to measure moisture content in polar materials such a alcohols.

Which of the above statements is/are correct
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

28. What is the output of a successive approximation type 8-bit ADC if the input is 491 mV and the reference is 512 mV?

(a) 11101011 (b) 11110101

(c) 11111011 (d) 11011010

Ans. (b)

SAR $\Rightarrow$ 8-bit ADC

V_{ref} = 512 mVolt, V_{input} = 491 mV

	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
	$\frac{V_{ref}}{2^1}$	$\frac{V_{ref}}{2^2}$	$\frac{V_{ref}}{2^3}$	$\frac{V_{ref}}{2^4}$	$\frac{V_{ref}}{2^5}$	$\frac{V_{ref}}{2^6}$	$\frac{V_{ref}}{2^7}$	$\frac{V_{ref}}{2^8}$
	$\frac{512}{2^1}$	$\frac{512}{2^2}$	$\frac{512}{2^3}$	$\frac{512}{2^4}$	$\frac{512}{2^5}$	$\frac{512}{2^6}$	$\frac{512}{2^7}$	$\frac{512}{2^8}$
	$\Downarrow$	$\Downarrow$	$\Downarrow$	$\Downarrow$	$\Downarrow$	$\Downarrow$	$\Downarrow$	$\Downarrow$
	256	128	64	32	16	8	4	2
V_g = 491 mV $\Rightarrow$	1	1	1	1	0	1	0	1

End of Solution

29. What is the percentage error in the measurement of kinetic energy of a body if the percentage error in the measurement of mass and speed is 2% and 3% respectively?

(a) 4% (b) 6%

(c) 8% (d) 12%

Ans. (c)

m = Mass = 2% $\Rightarrow \frac{\delta_m}{m}$ Speed = v = 3% $\Rightarrow \frac{\delta_y}{v}$

% Error in kinetic energy = ?

$$K \cdot E = \frac{1}{2}mV^2$$

$$\frac{\delta K \cdot E}{K \cdot E} = \frac{\delta_m}{m} + 2 \times \frac{\delta_v}{v} = 2\% + 2 \times 3\% = 8\%$$

End of Solution

30. A mass of 10 kg is measured with an instrument and the readings are normally distributed with respect to the mean of 10 kg. Given that

$$\frac{2}{\sqrt{2\pi}} \int_0^{0.84} \exp\left(\frac{-\eta^2}{2}\right) d\eta = 0.6$$

and 60 percent of the recordings are found to be within 0.05 kg from the mean. The standard deviation of the data is

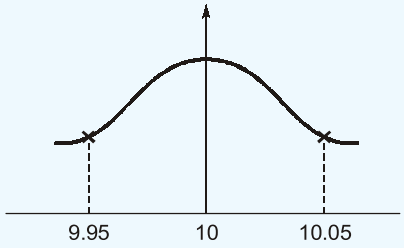
(a) 0.02 (b) 0.06

(c) 0.12 (d) 0.18

Ans. (b)

Find $\Rightarrow$ std $\Rightarrow \sigma$ = ?

Given $\Rightarrow \bar{X} = 10 \Rightarrow$ Mean and $z = 0.84$



Given $\Rightarrow \frac{2}{\sqrt{2\pi}} \int_{}^{0.84 \Rightarrow Z} e\left[\frac{-\eta^2}{2}\right] d\eta = 0.6$

$$Z = \frac{X - \bar{X}}{\sigma}$$

$$\Rightarrow \quad 0.84 = \frac{10.05 - 10}{\sigma}$$

$$\sigma = \frac{0.05}{0.84} \Rightarrow \sigma = 0.06$$

End of Solution

31. Which one of the following mid-band frequency of IF section is used in FM radio?
(a) 100.7 MHz (b) 10.7 MHz
(c) 0.455 MHz (d) 455 MHz

Ans. (b)

End of Solution

32. Consider the following statements
1. DSB-SC, SSB and VSB are examples of linear modulation
2. DSB-SC modulation is well suited for point-to-point communication.
3. SSB-SC modulation scheme is less affected by frequency selective fading

Which of the above statements is/are correct?
(a) 1 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Ans. (b)

End of Solution

33. Which one of the following schemes is used for transmission of the video signal in commercial television broadcasting?
(a) SSB (b) DBB
(c) VSB (d) FM

Ans. (c)

End of Solution

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34. A high resolution black and white TV picture consists of about 2×10^6 picture elements and 16 different brightness levels. Pictures are repeated at the rate of 32 per second. All picture elements are assumed to be independent and all levels have equal likelihood of occurrence. The average rate of information conveyed by this TV picture source is

(a) 4 Mb/s
(b) 256 Mb/s
(c) 64 Mb/s
(d) 16 Mb/s

Ans. (b)

Number of picture elements transmitted per second $= 32 \times 2 \times 10^6$

$\Rightarrow \quad r = 64 \times 10^6$ picture elements/sec

Given that 16 different brightness levels having equal probability.

$H = \log_2 16 = 4$ bits/brightness level

Each picture element exhibits one of the brightness level.

$H = 4$ bits/picture element

$R = rH = 64 \times 10^6 \times 4 = 256$ Mbps

End of Solution

35. A carrier is frequency modulated with a sinusoidal signal of 2 kHz, resulting in a maximum frequency deviation of 5 kHz. The bandwidth of the modulated signal is

(a) 14 kHz
(b) 24 kHz
(c) 10 kHz
(d) 48 kHz

Ans. (a)

Message free $\rightarrow f_m = 2$ kHz

$\Delta f = 5$ kHz

Bandwidth $= 2[\Delta f + f_m] = 14$ kHz

End of Solution

36. If, in addition to being stationary, the random process is also ergodic in nature, then the relation between power content P_X and autocorrelation function is

(a) $P_X = R_X(0)$
(b) $P_X \neq R_X(0)$
(c) $P_X = 2R_X(0)$
(d) $P_X = \frac{1}{2}R_X(0)$

Ans. (a)

End of Solution

37. In angle modulation, which of the following two factors limit the value of the modulation index β?

(a) Channel bandwidth and received power
(b) Pre-emphasis and de-emphasis
(c) Received noise power and signal power
(d) Pre-emphasis and received noise power

Ans. (a)

End of Solution

38. In which one of the following modulation schemes is the quantizer a 1-bit (two-level) quantizer with magnitudes $\pm\nabla$?

(a) PCM (b) DPCM
(c) DM (d) ADM

Ans. (c)

End of Solution

39. The average probability of bit error in each channel of the coherent QPSK system is (where E and N_0 are the signal energy and noise spectral density respectively)

(a) $\frac{1}{2}\text{erfc}\left(\sqrt{\frac{N_0}{2}}\right)$ (b) $\frac{1}{2}\text{erfc}\left(\sqrt{\frac{E/2}{N_0}}\right)$

(c) $\frac{1}{2}\text{erfc}\left(\sqrt{\frac{N_0/2}{E}}\right)$ (d) $\text{erfc}\left(\sqrt{\frac{E}{N_0}}\right)$

Ans. (*)

P_e of QPSK $= Q\left(\sqrt{\frac{2E_b}{N_0}}\right) = \frac{1}{2}\text{erfc}\left(\sqrt{\frac{E_b}{N_0}}\right)$ Options not matching.

End of Solution

40. Consider the following drawbacks avalanche of photodiodes:

1. Fabrication difficulties due to their more complex structure and hence increased cost.
2. The random nature of the gain mechanism which gives an additional noise contribution.
3. The high bias voltages required particularly for silicon devices (150 to 400 V) which although lower for germanium and InGaAs APDs (20 to 40 V) are similarly wavelength dependent.

Which of the above drawbacks is/are correct?

(a) 1 and 3 only (b) 2 only
(c) 2 and 3 only (d) 1, 2 and 3

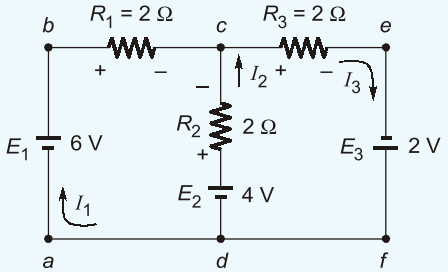
Ans. (d)

Avalanche photodiode drawbacks:

- Difficult to fabricate, complex structure.
- Additional noise.

End of Solution

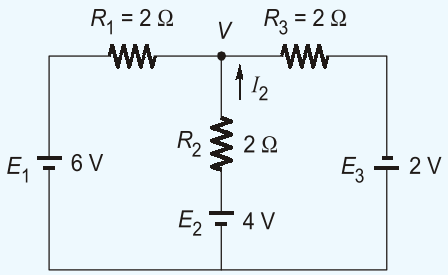
41. The current (I_2) of the circuit given below is



(a) 2 mA (b) 20 mA
(c) 0.2 A (d) 2 A

Ans. (c)

Given circuit,



By using nodal analysis at node 'V'

$$\frac{V-6}{2}+\frac{V-4}{2}+\frac{V+2}{4}=0$$

$$2V-12+2V-8+V+2=0$$

$$5V=18,\quad V=\frac{18}{5}$$

$$I_2=\frac{4-\frac{18}{5}}{2}=\frac{2}{10}=0.2\text{ A}$$

Hence, option (c) is correct.

End of Solution

42. The lithium intercalation reaction in Lithium-ion battery is

(a) $Li_x C_n \rightleftharpoons xLi^+ + x + C_n e^-$ (b) $Li_x C_n \rightleftharpoons xLi^+ + x + C_n$

(c) $Li_x C_n \rightleftharpoons xLi^+ e^- + x + C_n$ (d) $Li_x C_n \rightleftharpoons xLi^+ + xe^- + C_n$

Ans. (d)

End of Solution

43. The conversion efficiency of fuel cells is approximately

(a) 50% (b) 60%

(c) 70% (d) 80%

Ans. (b)

End of Solution

44. The magnetic core of a transformer is made up of stacks of thin laminations of cold-rolled grain-oriented silicon steel sheets of thickness

(a) 0.20 mm (b) 0.25 mm

(c) 0.30 mm (d) 0.35 mm

Ans. (d)

End of Solution

45. A relay which is used in oil-immersed transformers for protection against all kinds of faults, is known as

(a) Latching relay (b) Reed relay

(c) Solid state relay (d) Buchholz relay

Ans. (d)

End of Solution

46. A transistor with $\alpha = 0.98$ and $I_{CBO} = 5\ \mu A$ is biased, so that $I_{BQ} = 100\ \mu A$. What is the leakage current I_{CEO}?

(a) $I_{CEO} = 0.25$ mA
(b) $I_{CEO} = 25$ mA
(c) $I_{CEO} = 2.5$ mA
(d) $I_{CEO} = 0.25\ \mu A$

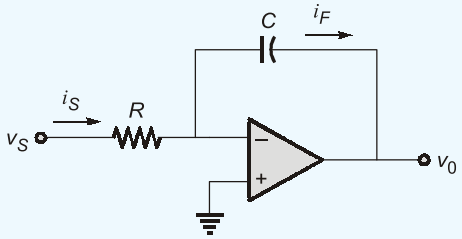
Ans. (a)

$$I_{CEO} = (1 + \beta)I_{CBO} \qquad \left(\because \beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{1-0.98} = 4.9\right)$$

$$I_{CEO} = (1 + 49) \times 5 \times 10^{-3}\ \text{mA}$$

End of Solution

47. Which one of the following is correct for the circuit shown below?



(a) Differentiating amplifier
(b) Integrating amplifier
(c) First order low pass filter
(d) Inverting amplifier

Ans. (b)

End of Solution

48. Consider the following statements regarding essential characteristics of a practical op-amp:

1. The open-loop voltage gain AOL is negatively infinite.
2. The input impedance between terminals 1 and 2 is infinitely large and the input current is zero.
3. The output impedance is zero and the output voltage is independent of the load.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans. (d)

$$A_{OL} = \infty$$
$$R_i = \infty$$
$$R_o = 0$$

End of Solution

49. Consider the following statements regarding common collector configuration:

1. The common-collector configuration is used primarily for impedance-matching purposes.
2. It has a high input impedance and low output impedance, opposite to that of the common-base configuration.
3. A common-collector circuit configuration is provided with the load resistor connected from emitter to ground.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans. (d)

End of Solution

50. I_{DSS} is the maximum drain current for a 50. JFET and is defined by the conditions

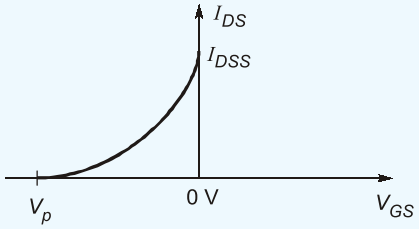
(a) $V_{GS} < 0$ V and $V_{DS} = |V_P|$
(b) $V_{GS} = 0$ V and $V_{DS} > |V_P|$
(c) $V_{GS} > 0$ V and $V_{DS} = 2V_P$
(d) $V_{GS} < 0$ V and $V_{DS} = -V_P$

Ans. (b)

$$I_{DS} = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$$

If V_{DS} = then $I_{DS} = I_{DSS}$

and $V_{DS} > |V_P|$



Alternate Solution:

$V_{GS} = 0, \quad V_{DS} \le |V_T|$

End of Solution

51. In which one of the following is it used that the particular operating wavelength can be selected at the time of device fabrication by an appropriate choice of the reflector spacing?

(a) Distributed feedback laser
(b) Fabry-Perot laser
(c) Tunable lasers
(d) A vertical cavity surface emitting laser

Ans. (a)

Distributed feedback laser.

End of Solution

52. Consider the following statements for an edge-emitting laser:

1. For small threshold current, Γ should be small to make the best use of the material gain.
2. A thick low band gap active region. (large Γ) leads to increased losses by internal absorption α_i.
3. For large material gain, the quantum well thickness should be large.
4. Absorption losses are often caused by absorption in the high band gap outer barriers forming the waveguide.

Which of the above statements are correct?

(a) 1 and 4 only
(b) 1, 2, 3 and 4
(c) 1 and 3 only
(d) 2 and 4 only

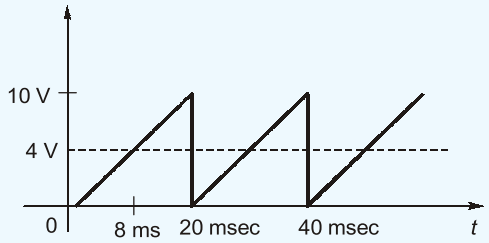
Ans. (d)

End of Solution

53. A 10 V, 50 Hz sawtooth wave is pulse width modulated by a 4 V signal. What are the outputs for high time and duty cycle respectively?

(a) 2 ms and 20%
(b) 4 ms and 40%
(c) 8 ms and 20%
(d) 8 ms and 40%

Ans. (d)



$\therefore$ High time = 8 msec

$$T_{ON} = \frac{8\,\text{ms}}{20\,\text{ms}} = 40\%$$

End of Solution

54. Which one of the following is correct regarding channel length modulation?

(a) Increasing V_{DS} causes the current to increase when the length factor L is increased.
(b) Increasing V_{DS} causes the current to decrease when the length factor L is decreased.
(c) Increasing V_{DS} causes the current to increase when the length factor L is decreased.
(d) Increasing V_{DS} causes the current to decrease when the length factor L is increased.

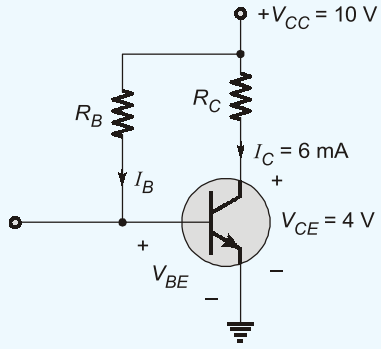
Ans. (a)

$$I_0' = \frac{I_D}{1 - \frac{\Delta L}{L}}$$

$\left(\because \frac{\Delta L}{L} = \text{Length factor increasese then } I_D' \text{ increases}\right)$

End of Solution

55. In the design of the fixed-bias transistor circuit shown in the figure, what are the values of R_C and R_B respectively for a Q-point of $I_C = 6$ mA and $V_{CE} = 4$ V, the transistor forward current gain is $\beta_F = 200$ with a negligible β_R, $V_{BE} = 0.7$ V?



(a) $R_C = 2\ \text{k}\Omega$, $R_B = 610\ \text{k}\Omega$
(b) $R_C = 1\ \text{k}\Omega$, $R_B = 310\ \text{k}\Omega$
(c) $R_C = 2\ \text{k}\Omega$, $R_B = 310\ \text{k}\Omega$
(d) $R_C = 1\ \text{k}\Omega$, $R_B = 610\ \text{k}\Omega$

Ans. (b)

Given: $1_C = 6$ mA ; $V_{CE} = 4$ V

$\beta_F = 200$; $V_{BE} = 0.7$ V

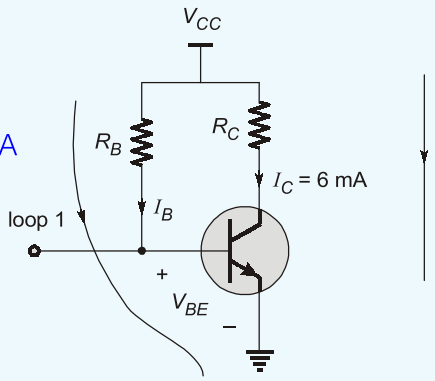
$$I_\beta = \frac{1_C}{\beta} = \frac{6}{200} = 3 \times 10^{-2} \text{ mA}$$

Apply KVL in loop-1, we get

$$R_B = \frac{10 - 0.7}{3 \times 10^{-2}} = 310 \text{ k}\Omega$$

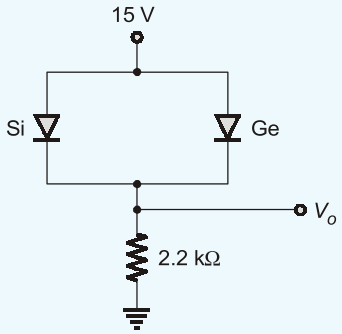
Apply KVL in loop-2, we get,

$$R_C = \frac{10 - 4}{6} = 1\text{k}\Omega$$



End of Solution

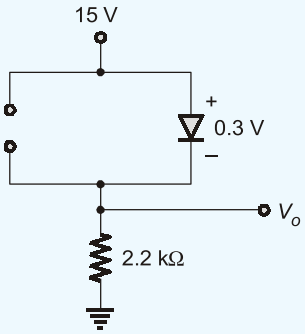
56. What is the output voltage Vo for the network given below?



(a) 13.3 V (b) 14.7 V

(c) 15 V (d) 16 V

Ans. (b)



Now, apply KVL in the above circuit,

$$15 - 0.3 - V_o = 0$$

$$\therefore \quad V_o = 14.7 \text{ V}$$

End of Solution

57. Consider the following statements:

1. The gain margin is defined as the value of $|A\beta|$ in decibels at the frequency which the phase angle of $A\beta$ is a radian.

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2. The phase margin is 180° minus magnitude of the angle of Aβ at frequency at which $|A\beta|$ is zero.
3. Oscillations will be sustained if, at the oscillator frequency, the magnitude of the product of the transfer gain of the amplifier and the magnitude of the feedback factor of the feedback network (the magnitude of the loop gain) is less than unity.

Which of the above statements are not correct?

(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

Ans. (d)

End of Solution

58. Consider the following statements regarding a Gaussian process:

1. If a Gaussian process is wide sense stationary, then the process is not stationary in the strict sense.
2. If the Gaussian process $X(t)$ is applied to a stable linear filter, then the random process $Y(t)$ developed at the output of the filter is also Gaussian.
3. If the random variables $X(t_1)$, $X(t_2)$ ... $X(t_n)$, obtained by sampling a Gaussian process $X(t)$ at times t_1, t_2 ... t_n are uncorrelated, n then these random variables are not statistically independent.

Which of the above statements is/are correct?

(a) 1 and 2
(b) 1 and 3
(c) 1 only
(d) 2 only

Ans. (d)

End of Solution

59. Consider the following statements regarding information theory:

1. The information capacity of a continuous channel of bandwidth B Hertz, perturbed by additive white Gaussian noise of power spectral density No/2 and limited in bandwidth to B, is $C = B\log_2\left(1+\frac{P}{N_0B}\right)$ bits per second, where P is the average transmitted power.
2. The mutual information is always non-negative.
3. The mutual information of a channel is symmetric
4. The mutual information of the channel is related to the joint entropy of the channel input and channel output by $I(x, y) = H(x) - H(y) + H(x, y)$.

Which of the above statements are correct?

(a) 1, 2 and 3 only
(b) 2 and 3 only
(c) 2, 3 and 4 only
(d) 1, 2, 3 and 4

Ans. (a)

End of Solution

60. Consider the following statements regarding the communication system:

1. The baseband signal contains frequencies in the audio frequency range, some form of frequency-band shifting must be employed for the radio communication system to operate properly.
2. Digital repeaters reconstruct the received digital data by minimizing the effect of signal attenuation and distortion. Thus channel noise is not cumulative.
3. A digital signal can be propagated through a limited distance only, otherwise higher signal attenuation can introduce unacceptable errors.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (d)

End of Solution

61. Consider the following statements:

1. In induction machine, the field winding is placed on the stator and the armature winding on the rotor.
2. In DC machine, the stator windings serve as both armature windings and field windings.
3. In synchronous machine, the rotor carries the field winding and the stator carries the armature winding.

Which of the above statements is/are correct?

(a) 1 only
(b) 2 only
(c) 3 only
(d) 1, 2 and 3

Ans. (c)

End of Solution

62. Consider the following statements:

1. The coordination number and the atomic packing factor for the Hexagonal Close-Packed (HCP) crystal structure are less than the Body-Centered Cubic (BCC) crystal structure.
2. The coordination number and the atomic packing factor for the Hexagonal Close-Packed (HCP) crystal structure are greater than the Face-Centered Cubic (FCC) crystal structure.
3. The coordination number and the atomic packing factor for the Hexagonal Close-Packed (HCP) crystal structure are equal to the Face-Centered Cubic (FCC) crystal structure.

Which of the above statements is/are not correct?

(a) 1 only
(b) 1 and 2 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (b)

	Coordination Number	APF
BCC	8	0.68
FCC	12	0.74
HCP	12	0.74

End of Solution

63. The equilibrium number of vacancies N_V for a given quantity of material
(a) increases linearly with temperature (b) increases exponentially with temperature
(c) decreases linearly with temperature (d) decreases exponentially with temperature

Ans. (b)

$$N_v = N\exp\left(-\frac{Q_V}{kT}\right)$$

where,
N_V = Equilibrium number of vacancies
N = Total number of atomic sites
Q_V = Energy required for formation of a vacancy
K = Boltzmann is constant
T = Temperature

x

End of Solution

64. Silicon Carbide (SiC) has
(a) a Rock Salt crystal structure (b) a Cesium Chloride crystal structure
(c) a Zinc Blende crystal structure (d) a Perovskite crystal structure

Ans. (c)
Zns, ZnTe, Cds, InAs and SiC etc. exhibit zinc blends crystal structure.

End of Solution

65. Match the following lists:

List-I (Composites)	List-II (Sub classification of composite)
P. Particle-reinforced composites	1. Laminates
Q. Fiber-reinforced composites	2. Dispersion strengthened
R. Structural composites	3. Discontinuous (short)

Select the correct answer using the code given below:

	P	Q	R
(a)	1	2	3
(b)	3	1	2
(c)	2	3	1
(d)	2	1	3

Ans. (c)

- Particle reinforced composites → Dispersion strengthened.
- Fiber-reinforced composites → Discontinuous (short)
- Structural composites → Laminates

End of Solution

66. The critical fiber length of the fiber-reinforced composite ranges between
(a) 5 and 20 times the fiber diameter (b) 150 and 200 times the fiber diameter
(c) 150 and 250 times the fiber diameter (d) 20 and 150 times the fiber diameter

Ans. (a)

For a number of glass and carbon fiber-matrix combinations, the critical length is on the order of 1 nm, which ranges between 20 and 150 times the fiber diameter.

Alternate Solution:

Always fiber reinforced will be small in compared to diameters.

End of Solution

67. Match the following lists:

List-I (Material)	List-II (Magnetism)
P. Silicon	1. Ferromagnetic
Q. Molybdenum	2. Diamagnetism
R. Cobalt	3. Paramagnetism

Select the correct answer using the code given below:

	P	Q	R
(a)	1	2	3
(b)	2	3	1
(c)	2	1	3
(d)	3	2	1

Ans. (b)

- Silicon → Diamagnetism
- Molybdenum → Paramagnetism
- Cobalt → Ferromagnetic

End of Solution

68. The cross-correlation of two finite length sequences $x(n) = \{1, 2, 1, 1\}$ and $y(n) = (1, 1, 2, 1\}$ is
(a) {1, 2, 5, 6, 6, 4, 1} (b) (1, 1, 4, 6, 6, 5, 2}
(c) (5, 2, 1, 1, 4, 6, 6) (d) (1, 4, 6, 6, 5, 2, 1)

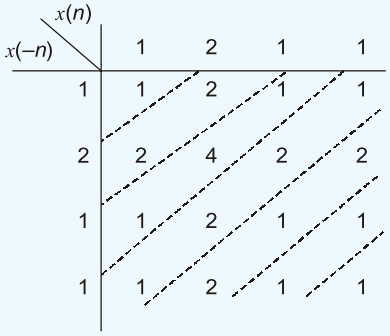
Ans. (d)

Given: $x(n) = \{1, 2, 1, 1\}$ and $y(n) = (1, 1, 2, 1\}$

$$R_{XY}(n) = x(n) * y(-n)$$

$$R_{XY}(n) = \underset{\uparrow}{\{1, 2, 1, 1\}} * \{1, 2, 1, \underset{\uparrow}{1}\}$$

Using tabular method:



$R_{XY}(n) = \{1,\ 4,\ 6,\ \underset{\uparrow}{6},\ 5,\ 2,\ 1\}$

End of Solution

69. Consider the following relations of continuous time unit impulse function:

1. $\delta(t) = \delta(-t)$
2. $\int_{-\infty}^{+\infty} x(t)\,\delta(t)\,dt = x(0) = 0$
3. $\delta(at) = \frac{1}{|a|}\delta(t)$

Which of the above relations is/are correct

(a) 2 only (b) 1 and 2
(c) 1 and 3 (d) 2 and 3

Ans. (c)

End of Solution

70. Consider the following statements:

1. Impulse response $h_1(n) = 3^n u(n)$ indicates the system is non-causal system.
2. Impulse response $h_2(n) = \cos\frac{n\pi}{2}$ indicates the system is causal system.
3. Impulse response $h_3(n) = e^{-5|n|}$ indicates the system is causal system.

Which of the above statements is/are not correct?

(a) 3 only (b) 1 and 2
(c) 1 and 3 (d) 2 and 3

Ans. (*)

All options are wrong. No option is matching.

End of Solution

71. The system represented by
$5s^6 + 8s^5 + 12s^4 + 20s^3 + 100s^2 + 150s + 200 = 0$ is
(a) a stable system having all poles in the right half of the s-plane.
(b) an unstable system having one pole in the right half of the s-plane.
(c) a stable system having one pole in the right half of the s-plane.
(d) an unstable system having two poles in the right half of the s-plane.

Ans. (d)

We have, characteristics equation
$5s^6 + 8s^5 + 12s^4 + 20s^3 + 100s^2 + 150s + 200 = 0$
Now, by using R-H criterion,

s^6	5	12	100	200
s^5	8	20	150	
s^4	–0.5	6.25	200	
s^3	120	3350		
s^2	20.2	200		
s^1	2162.35			
s^0	200			

∴ Sign is change twice hence, system is unstable and having two poles in the right half of s-plane.
Hence, option (d) is correct.

End of Solution

72. For the unity feedback system given by $(s) = \dfrac{K}{s(s+1)(s+2)}$, the range of K for stability is
(a) $0 < K < 2$ (b) $0 < K < 3$
(c) $0 < K < 6$ (d) $1 < K < 6$

Ans. (c)

We have, OLTF $= G(s)H(s) = \dfrac{K}{s(s+1)(s+2)}$ $(\because H(s) = 1)$

Characteristic equation,
$1 + G(s)H(s) = 0$
$(s^2 + s)(s + 2) + K = 0$
$s^3 + 2s^2 + s^2 + 2s + K = 0$
$s^3 + 3s^2 + 2s + K = 0$
Now, using R-H criterion,

s^3	1	2
s^2	3	K
s^1	$\dfrac{6-K}{3}$	
s^0	K	

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$6 - K > 0$

$6 > K \quad ; \quad K > 0$

Hence, for stable system $0 < K < 6$.

End of Solution

73. What are the breakaway points of the root locus of a unity feedback system with open loop transfer function $G(s) = \dfrac{K(s+2)}{(s+1)^2}$?

(a) –1, 2 (b) –1, 3

(c) –1, –2 (d) –1, –3

Ans. **(d)**

We have,

$$\text{OLTF,} \qquad G(s)H(s) = \frac{K(s+2)}{(s+1)^2}$$

$$(s+1)^2 + K(s+2) = 0$$

$$K = -\frac{(s+1)^2}{(s+2)}$$

$$-\frac{dK}{ds} = \frac{(s+2)\,2(s+1) - (s+1)^2}{(s+2)^2} = 0$$

On solving equation, we get,

$$S = -1, -3$$

Hence, option (d) is correct.

End of Solution

74. Consider the following statements regarding the Bode plot for the type-2 system having transfer function of the form:

$$G(j\omega) = \frac{K}{(j\omega)^2\,(1+j\omega T)}$$

1. The intercept of the low frequency slope of –40 dB/decade (or its extension) with the 0 dB axis occurs at a frequency ω_X, where $\omega_X = K$
2. The value on the low frequency slope of –40 dB/decade (or its extension) at the frequency $\omega = 1$, is equal to 40 log (K).
3. The gain K is the static ramp error coefficient.

Which of the above statements is/are not correct?

(a) 1 only (b) 1 and 2

(c) 1 and 3 (d) 2 and 3

Ans. **(*)**

We have,

$$\text{OLTF,} \qquad G(j\omega) = \frac{K}{(j\omega)^2\,(1+j\omega T)}$$

$$G(j\omega)\big|_{dB} = -20r\log_{10}\omega + 20\log_{10}K$$

$$M_{dB} = -20r\log_{10}\omega + 20\log_{10}K$$
$$0 = -(20 \times 2)\ \log 10\omega_x + 20\log_{10}\ K$$
$$\omega_x^2 = K \quad \ldots \quad \text{Hence, statement 1 is false.}$$

- From Bode plot curve, we get that at low frequency slope of –40 dB/decade at the frequency $\omega = 1$, is equal to $20\log K$. Hence, statement 2 is also not correct.
- The static ramp error coefficient for the given system is 0. Hence, statement 3 is also not correct.

Therefore, none of the options are matched.

End of Solution

75. Consider the following statements:

1. Gain margin is used to indicate the proximity of the intersection of the negative real axis made by the polar plot of $G(j\omega)H(j\omega)$ to the $(-1+ j)$ point.
2. Phase crossover point is the point in the $G(j\omega)$ plane at which the polar $G(j\omega)H(j\omega)$ plot intersects the positive real axis.
3. The phase crossover frequency is the frequency at the phase crossover point or where angle $\{G(j\omega)H(j\omega)\} = 180°$.

Which of the above statements is/are not correct?

(a) 2 only (b) 1 and 2 only
(c) 1 and 3 only (d) 2 and 3 only

Ans. (b)

End of Solution

76. Which one of the following adders divides the full adder into groups and employs carry bypass logic to speed up the carry propagation?

(a) Pseudo parallel adder (b) Carry look-ahead adder
(c) Ripple carry adder (d) Binary parallel adder

Ans. (b)

End of Solution

77. Number of flip-flops needed to design a twisted-ring counter (SN7400 series), that has ten unique states, is

(a) 5 (b) 2
(c) 10 (d) 4

Ans. (a)

End of Solution

78. Match the following lists :

List-I	List-II
P. Format control	1. NAK, ETB
Q. Transmission control	2. RS, US
R. Information separator	3. EM, DC1, DC2, DC3, DC4
S. Miscellaneous	4. FF, VT

Select the correct answer using the code given below :

	P	Q	R	S
(a)	2	1	3	4
(b)	4	3	1	2
(c)	3	1	4	2
(d)	4	1	2	3

Ans. (a)

End of Solution

79. Common error control techniques are not based on
(a) error detection
(b) positive acknowledgement and retransmission
(c) retransmission after time out
(d) negative acknowledgement

Ans. (b)

End of Solution

80. Match the following lists :

List-I		List-II
P.	SCMA	1. Interleavers are used as the only means for user separation
Q.	MC-CDMA	2. Applies a new set of spreading codes that exhibit interference free window to separate users in the wireless channel.
R.	IDMA	3. Enables two or more users, associated with the same base station, to use the same time and frequency and code resources on the grounds of their physical location or spatial separation
S.	LAS-CDMA	4. Spreads each user symbol in the frequency domain

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	4	3	1
(b)	3	4	1	2
(c)	1	2	4	3
(d)	4	3	2	1

Ans. (a)

End of Solution

81. Which one of the following is **not** the property of WiseMAC?
(a) The preamble duration is determined by the potential clock drift since last synchronization.
(b) It uses additional contents of ACK packets.
(c) Preamble T_P is $\min(L_\theta, 4T_W)$.
(d) The packets in WiseMAC also contain a "more" bit.

Ans. (c)

End of Solution

82. A cell-site transmitter generates +15 dBm RF signal and is connected to an antenna using an RF coaxial cable that induces a 3 dB loss. The cable has two connectors at its either end that induce a loss of 2 dB each. What is the signal level at the input of the antenna?

(a) +5 dBm (b) +6 dBm
(c) +7 dBm (d) +8 dBm

Ans. (d)

Given that,

$$L_{cable} = 3 \text{ dB}$$
$$L_{connector} = 2 \times 2 \text{ dB} = 4 \text{ dB (due to 2 connectors)}$$
$$P_{out} = P_{in} - L_{cable} - L_{connector}$$
$$P_{out} = 15 \text{ dBm} - 3 \text{ dB} - 4 \text{ dB}$$
$$P_{out} = 8 \text{ dBm}$$

End of Solution

83. Which one of the following is **not** the property of flooding?

(a) An effective routing approach when the information in the routing tables is not available.
(b) It may easily swamp the network as one packet creates multiple packets that in turn create multiples of multiple packets, generating an exponential growth rate.
(c) TTL is used to reduce the resource consumption in the network.
(d) It requires the network to provide multiple paths for each source—destination pair.

Ans. (d)

Flooding does not require the network to provide the multiple paths.

End of Solution

84. Which one of the following is a disadvantage of CDMA?

(a) It is simple to operate.
(b) It does not require any transmission synchronization between stations. The only synchronization required is that of the receiver to the sequence of the received carrier.
(c) It offers sufficient protection against interference from other stations and due to multiple paths.
(d) It has low throughput.

Ans. (d)

CDMA provides increased capacity, security and efficient utilization. It has typically lower throughput compared to other media access techniques like TDMA and FDMA.

End of Solution

85. Which one of the following statements is correct for ST connector?

(a) It uses a ceramic ferrule and a rugged metal housing. It is latched in place by twisting.
(b) It has a shockproof plastic housing with a retractable shroud to protect the ceramic ferrules from damage.
(c) It is designed for multimode data communication applications and it is used for instrumentation connections.
(d) It allows high-density connections between network equipment in telecommunication rooms.

Ans. (a)

ST connector [Straight Tip connector] indeed features a specific ferrule design housed in a ragged metal housing.

End of Solution

86. Network and switching subsystem does **not** have which one of the following switches and databases?

(a) Mobile services switching center
(b) Home location register
(c) Visitor location register
(d) Operation and maintenance center

Ans. (d)

Network switching sub system consists of MSC, HLR and VLR.

OMC is responsible for network monitoring management and maintenance task but not typically a part of NSS.

End of Solution

87. Which one of the following statements is **not** correct about the D-channel contention-resolution algorithm?

(a) When a subscriber device has an LAPD frame to transmit, it transmits a series of binary ones on the D-channel using the pseudoternary encoding scheme.
(b) The NT, on receipt of a D-channel bit, reflects back the binary value as a D-channel echo bit.
(c) When a terminal is ready to transmit an LAPD frame, it listens to the stream of incoming D-channel echo bits.
(d) To overcome collision, a transmitting TE monitors the E bits and compares them to its transmitted D bits. If a discrepancy is detected, the terminal ceases to transmit and returns to a listen state.

Ans. (a)

End of Solution

88. Which one of the following is **not** an advantage of a WLAN?

(a) Only wireless ad-hoc networks allow for communication without previous planning.
(b) Several Government and non-Government institutions worldwide regulate the operation and restrict frequencies to minimize interference.
(c) Wireless networks allow for the design of small, independent devices.
(d) Wireless networks are robust.

Ans. (a)

End of Solution

89. Consider the following statements :

1. The VLSI circuit (all the devices and their interconnections) is fabricated on a die. In a single wafer, there are always two dies. The complete one VLSI circuit is equally distributed (fabricated) on each die.

2. Modern technologies use a diamond saw to separate the dies from the wafer.
3. A suitable compound material is used to package the die to provide protection to the die from environmental damage, to prevent the interface to the outside world, to provide the cooling of heat generated due to power dissipation.

Which of the above statements is/are correct ?

(a) 1 and 2 (b) 2 and 3
(c) 2 only (d) 3 only

Ans. (d)

End of Solution

90. Consider the following statements :

1. Programmable Logic Array (PLA) is a programmable logic device with AND array followed by the OR array, where the AND array is programmable but the OR array is fixed.
2. Additional input in PLA does not require doubling the size of AND and OR array. Therefore, PLA is cheaper than Programmable Array Logic (PAL).
3. PLA is more flexible as compared to PAL and Read Only Memory (ROM).
4. PLA, PAL and ROM can be used to implement sum of product (SOP) with any number of terms.

Which of the above statements are not correct?

(a) 1, 2, 3 and 4 (b) 1 and 2 only
(c) 3 and 4 only (d) 1, 2 and 4 only

Ans. (b)

We know that

- ROM consists of fixed AND gate and programmable OR gate.
- PLA consists of programmable AND and programmable OR gate.
- PAL consists of programmable AND and fixed OR gate.

End of Solution

91. If in an n-bit carry skip adder divided into M blocks, each block is containing P adder cells, then, the total (worst case) propagation delay time is given by (k_1 denotes the time needed by the carry signal to propagate through the adder cell, k_2 denotes the time needed for a carry to skip over a block)

(a) $2(P-1)k_1 + (M-2)k_2$ (b) $2(M-1)k_1 + (P-2)k_2$
(c) $(P-1)k_2 + (M-2)k_1$ (d) $(P-1)k_1 + 2(M-2)k_2$

Ans. (c)

End of Solution

92. In MOS transistor, the depletion region width d for the junction is (ε_{si} = relative permittivity of silicon, ε_0 = permittivity of free space, V = effective voltage across the junction, q = electron charge, N = doping level of substrate)

(a) $d = \sqrt{\frac{2\varepsilon_{si}\varepsilon_0 V}{qN}}$ (b) $d = \sqrt{\frac{2\varepsilon_{si}\varepsilon_0}{qNV}}$

(c) $d = \sqrt{\frac{\varepsilon_{si}\varepsilon_0 V}{qN}}$ (d) $d = \sqrt{\frac{\varepsilon_{si}\varepsilon_0 V}{2qN}}$

Ans. (a)

$$d = \sqrt{\frac{2\varepsilon_{si}\varepsilon_0 V}{qN}}$$

End of Solution

93. Consider the following statements regarding the instruction pipelining :

1. It is used for increasing the efficiency of the advanced microprocessors.
2. Pipelining a processor means breaking down its instruction into a series of discrete pipeline stages which can be completed in sequence by specialized hardware.
3. The performance and programming simplification is achieved by pipelining operation with the elimination pipeline interlocks and the control of pipeline is simplified.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

94. Sample $x(t)$ at the rate of 10 samples per second. What is the ROC of its z-transform directly from $x(n)$, if the input signal $x(t) = [-2e^{-3t} + 3e^{-4t}]u(t)$?

(a) $Z = 0.7408$ (b) $Z = 0.6703$

(c) $|Z| > 0.6703$ (d) $|Z| > 0.7408$

Ans. (d)

Given:

Sampling rate $f_s = 10$ Hz

$$x(t) = \left[-2e^{-3t} + 3e^{-4t}\right]u(t)$$

So, $$x(n) = x(t)\big|_{t = nT_s} = x(t)\big|_{t = \frac{n}{f_s}}$$

$\therefore$ $$x(n) = \left[-2e^{-\frac{3n}{10}} + 3e^{-\frac{4n}{10}}\right]u(n)$$

$$= -2e^{-\frac{3}{10}n}u(n) + 3e^{-\frac{2}{5}n}u(n)$$

ROC of $x(n)$: $\left(|z| > e^{-\frac{3}{10}}\right) \cap \left(|z| > e^{-\frac{4}{10}}\right)$

: $(|z| > 0.74) \cap (|z| > 0.67)$

: $|z| > 0.7408$

End of Solution

95. Matched-z transformation method is used to design

(a) Inverse Chebyshev filter
(b) Non-recursive filters
(c) All pole filters
(d) Recursive filters

Ans. (d)

End of Solution

96. How many m-bit data words can be stored using an n-input, m-output programmable read only memory?

(a) $\frac{2^n}{n}$
(b) $n \times 2^n$
(c) 2^n
(d) 2^{n-1}

Ans. (c)

End of Solution

97. How many numbers of unique states are possible in twisted ring counter with 5 flip flops?

(a) 32
(b) 5
(c) 10
(d) 16

Ans. (c)

For Jhonson counter or twisted ring counter,
number of unique states = $2N$
where given, $n = 5$
$\therefore$ $2N = 2 \times 5 = 10$

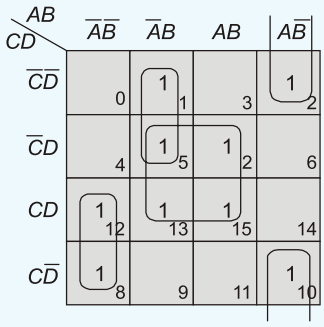
End of Solution

98. Essential prime implicants of the given K-map are

CD \ AB	00	01	11	10
00	0	4 1	12	8 1
01	1	5 1	13 1	9
11	3 1	7 1	15 1	11
10	2 1	6	14	10 1

(a) $\bar{A}\bar{B}C, A\bar{B}\bar{D}, \bar{A}\bar{B}C$
(b) $\bar{A}\bar{B}\bar{C}, A\bar{B}\bar{D}, BD, \bar{A}\bar{B}C, \bar{A}CD, \bar{B}C\bar{D}$
(c) $A\bar{B}C, \bar{A}CD, \bar{B}C\bar{D}$
(d) $\bar{A}\bar{B}\bar{C}, A\bar{B}\bar{D}, BD$

Ans. (d)



$EPI = BD,\ \bar{A}\bar{B}\bar{C},\ A\bar{B}\bar{D}$

End of Solution

99. A 12-stage counter is operating a 12-stage ladder network using a reference voltage of 10 V. If a clock rate of 1 MHz is operating a 12-stage counter, then the maximum conversion time (approximately) is

(a) 1.20 ms (b) 4.10 ms

(c) 12.10 ms (d) 24.40 ms

Ans. (b)

Maximum conversion time $= (2^N - 1)T$

where $N = 12$

$$T = \frac{1}{10^6} = 1\,\mu\text{sec}$$

$\therefore$ Max' Conversion time $= (2^{12} - 1) \times 1$ msec $= 4096\ \mu$sec $= 4.096$ msec

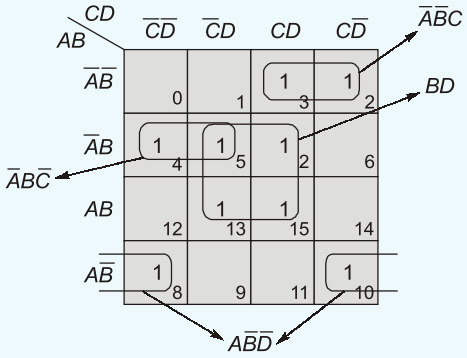
End of Solution

100. Minimized function of the Boolean function $f(A, B, C, D) = \Sigma M(2, 3, 4, 5, 7, 8, 10, 13, 15)$ is

(a) $\bar{A}\bar{B}C + \bar{A}B\bar{C} + BD + A\bar{B}\bar{D}$ (b) $\bar{A}\bar{B}C + AB\bar{C}\bar{D} + AC + A\bar{B}\bar{D}$

(c) $\bar{B}C\bar{D} + \bar{A}\bar{B}C + \bar{A}B\bar{C} + BD + A\bar{B}\bar{D}$ (d) $\bar{A}\bar{B}CD + \bar{A}B\bar{C}D + AC + A\bar{B}\bar{D}$

Ans. (a)



Hence $Y = \bar{A}\bar{B}C + \bar{A}B\bar{C} + BD + A\bar{B}\bar{D}$

End of Solution

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101. IC 74157 is a

(a) 2-bit two-input multiplexer
(b) 4-bit two-input multiplexer
(c) 8-bit two-input multiplexer
(d) 4-bit four-input multiplexer

Ans. (b)

End of Solution

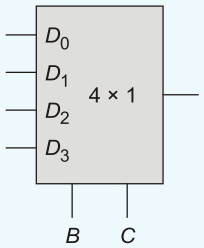
102. When implementing $F(A, B, C) = AB + \bar{B}C$ with 4 : 1 multiplexer, the correct input sequence of multiplexer's input D_0, D_1, D_2 and D_3 are respectively

(a) $C, 1, C, 0$
(b) $0, 1, \bar{A}, A$
(c) $C, 0, C, 1$
(d) $1, 0, \bar{A}, A$

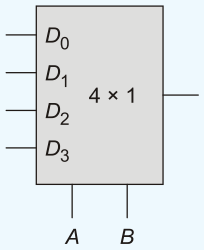
Ans. (c)

	$\bar{B}\bar{C}$	$\bar{B}C$	BC	$B\bar{C}$
$\bar{A}$	0	1 1	3	2
$\bar{A}$	4	1 5	1 7	6

$f(A, B, C) = \Sigma m(1, 5, 6, 7)$



	D_0	D_1	D_2	D_3
$\bar{A}$	0	1	2	3
A	4	⑤	⑥	⑦
	0	1	A	A



	D_0	D_1	D_2	D_3
$\bar{C}$	0	2	4	⑥
C	①	3	⑤	⑦
	C	0	C	1

Hence, option (c) is correct answer.

End of Solution

103. IC 74273 is for

(a) a positive-edge triggered D flip-flop with clear inputs
(b) a negative-edge triggered D flip-flop with clear inputs
(c) a pulse-triggered JK flip-flop with preset and clear inputs
(d) a negative-edge triggered JK flip-flop with preset and clear inputs

Ans. (a)

IC74273 option (a).
Possible edge triggered D flip-flop.

End of Solution

104. Consider the following statements regarding the sequential circuit :
1. The Moore model sequential circuit is called transition-assigned circuit.
2. In the Mealy model sequential circuit, the output is associated with the state transitions, that is, the arcs in the state diagram.
3. In the Moore model sequential circuit, outputs are the functions of both, the inputs and the present state.

Which of the above statements are not correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)

End of Solution

105. Consider the following statement regarding the Programmable Array Logic (PAL):
1. A PAL comprises programmable AND and OR array,
2. Unlike a PROM, in which all 2^n possible products of n variables are generated, a PAL generates only a limited number of product terms, leaving it to the designer to select those products to be generated for each sum.
3. The overall cost of a PAL is considerably lower than that of comparable PROMs and FPLAs.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

106. In the international system of units (SI), charges Q_1, Q_2 are expressed in Coulombs, distance R in meters, and the force in Newtons. The constant of proportionality k is

(a) 6×10^{-7} m/F (b) 9×10^{9} m/F
(c) 5×10^{8} m/F (d) 7×10^{-9} m/F

Ans. (b)

From Coulomb's law; $F = \dfrac{k\, q_1 q_2}{r^2}$

$\Rightarrow \quad N = k \cdot \dfrac{c^2}{m^2}$ [in SI units]

$\Rightarrow \quad K = \dfrac{N - m^2}{c^2}$ unit $= 9 \times 10^9$ magnitude

As, $1F = \dfrac{c^2}{N - m}$

$\Rightarrow \quad \dfrac{m}{F} = \dfrac{N - m^2}{c^2} = k$

$\therefore \quad k = 9 \times 10^9$ m/F $= 9 \times 10^9 \dfrac{N - m^2}{c^2}$

End of Solution

107. Which one of the following does **not** indicate the space pervasiveness of electromagnetic effects?

(a) The presence of current in two circuits in proximity to each other is accompanied by electrical forces on each conductor, forces which change if either current is changed.

(b) A changing of the current in either of two such circuits is accompanied by an induced voltage in the other.

(c) Capacitors consisting of metallic spheres or other conducting bodies suspended in vacuum or in an insulating medium may be charged and later discharged. During these processes wire-borne current flows onto one sphere and off the other.

(d) The presence of electric charges on two bodies is accompanied by a mechanical force on each, forces which change if either charge is changed.

Ans. (d)

End of Solution

108. Which one of the following points is **not** related to Poynting's Theorem?

(a) The variations in the time of a term corresponding to the sum of the energies associated to the electric and magnetic fields, and stored along the line.

(b) The power dissipated along the line due to the Joule effect in the conductors and the losses in the dielectric.

(c) The flux of the Poynting vector is coming out from the ends of the line, $p(d, t) - p(0, t)$.

(d) This theorem is not applicable to the more general case of transmission lines with frequency-dependent parameters.

Ans. (c)

End of Solution

109. Which one of the following is **not** applicable to Channel guides?

(a) It cannot provide confinement in the x dimension.

(b) It is confinement of the light within the film plane, i.e. the y-z plane.

(c) It is used in many active and passive devices of integrated optics, including lasers, modulators, switches and directional couplers.

(d) It is used in the design of single-mode structures that are compatible with single-mode fiber guides.

Ans. (a)

Channel guides are structure used in optics to confine light propagation in all directions x, y and z.

End of Solution

110. What is the radiation resistance of an infinitesimal dipole whose overall length $l = \lambda/50$?

(a) 0.316 Ω (b) 1.5 Ω

(c) 1.25 Ω (d) 2.25 Ω

Ans. (a)

Radiation resistance for $l = \frac{\lambda}{50}$

$$R_{rad} = 80\pi^2\left[\frac{l}{\lambda}\right]^2 = 80\pi^2\left[\frac{1}{50}\right]^2 = 0.316\ \Omega$$

End of Solution

111. When two antennas are near each other, some of the energy that is primarily intended for one ends up at the other. The amount does **not** depend on

(a) radiation characteristics of each
(b) relative separation between them
(c) relative orientation of each
(d) mutual coupling between them

Ans. (d)

Antenna elements influence the other elements and gets influenced by other elements in proximity known as mutual coupling between antennas and it depends on various factors like number and type of antenna elements, interelement spacing, relative orientation of elements, radiation characteristics of the radiators, bandwidth scan angles etc.

End of Solution

112. Match the following lists:

List-I	List-II
P. Cavity-backed printed antennas	1. Difficult to make conformal
Q. Triplate	2. Low efficiency
R. Waveguide	3. Narrow bandwidth
S. Microstrip antennas	4. Coupling occurs inside structure

Select the correct answer using the code given below:

	P	Q	R	S
(a)	2	3	4	1
(b)	3	4	1	2
(c)	2	1	3	4
(d)	4	1	3	2

Ans. (b)

End of Solution

113. Which one of the following properties is not correct for skin depth?

(a) If the frequency is higher, then the skin depth is smaller.
(b) If the permeability is larger, then the skin depth is smaller.
(c) If the conductivity is larger, then the skin depth is smaller.
(d) If the permeability is larger, then the skin depth is smaller.

Ans. (*)

None

End of Solution

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114. A slot antenna of dual monopole feed has
(a) 3—4 bands, wide bandwidth, low height, high fabrication complexity
(b) 1—4 bands, narrow bandwidth, large height, low fabrication complexity
(c) 2—3 bands, wide bandwidth, low height, low fabrication complexity
(d) 1 — 2 bands, narrow bandwidth, medium height, low fabrication complexity

Ans. (a)

End of Solution

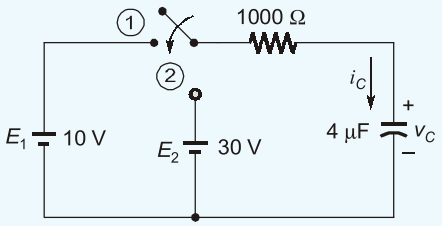
115. Consider the following statements regarding the antenna arrays :
1. A broadside array has its maximum radiation directed along the axis of the array.
2. An end-fire array has its maximum radiation directed along the axis of the array.
3. The resultant pattern for an array, which is known as pattern multiplication, is the product of the unit pattern and the group pattern.

Which of the above statements is/are correct?
(a) 1 and 2
(b) 1 and 3
(c) 2 and 3
(d) 2 only

Ans. (c)

End of Solution

116. The capacitor in the figure given below is uncharged. The switch is moved to position 1 for 5 ms, then to position 2 and left there. What is the current (i_C) while the switch is in position 2?



(a) $21.86\ e^{-250t}$ mA
(b) $218\ e^{-250t}$ mA
(c) $286\ e^{-250t}$ mA
(d) $22.86\ e^{-250t}$ mA

Ans. (d)

Voltage across the capacitor

$$V_c(t) = V_c(\infty) + (V_c(0) - V_c(\infty))e^{-t/\tau}$$

$$V_c(0^+) = 0\ \text{V},\ V_c(\infty) = 10\ \text{V},\ t = RC = (1000)\ (4\ \mu) = 4\ \text{msec}$$

$$V_c(t) = 10(1 - e^{-t/4\times10^{-3}})$$
$$V_c(t) = 10(1 - e^{-250t})$$

At $t = 5$ msec, $V_c(t) = 10(1 - e^{-250\times5\times10^{-3}})$

$$V_c(t) = 7.315\ \text{V}$$
$$V_c(5^+) = 7.135\ \text{V}$$
$$V_c(\infty) = 30\ \text{V}$$

$$V_c(t) = 30 + (7.135 - 30)e^{-(t-5\times10^{-3})/4\times10^{-3}}$$

$$i_c(t) = c\frac{dV_c}{dt} = 4\times10^{-6}\frac{d}{dt}[(30)-(22.865)]\times(t-5\times10^{-3})/4\times10^{-3}$$

$$= 4\times10^{-6}(22.865e^{-(t-5\times10^{-3}/4\times10^{-3})}\frac{1}{4\times10^{-3}}$$

$$= 22.865e^{-(t-5\times10^{-3})250}\ \text{mA}$$

End of Solution

117. Which one of the following digital logic families has the worst noise immunity and power dissipation among all the digital logic families?

(a) TTL (b) ECL
(c) RTL (d) DTL

Ans. (b)

In ECL, Noise margin = 0.3 V
More power dissipation.

End of Solution

118. The quiescent point (*Q*-point) of the BJT is selected in such a way that the gain of the BJT is

(a) increased exponentially with input signal
(b) decreased with input signal
(c) increased with input signal
(d) fairly constant

Ans. (d)

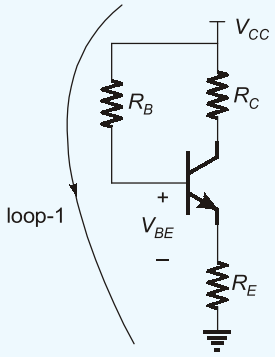
The quiescent point (*Q*-point) of the BJT is selected in such a way that gain of the BJT i.e. β should remain fairaly constant.

End of Solution

119. What are the stability factor $S(V_{BE})$ and the change in collector current I_C, respectively from 25°C to 100°C for the emitter-bias transistor configuration with R_B = 240 kΩ, R_E = 1 kΩ and β = 100? (Take the change in voltage V_{BE} due to change in temperature to be –0.17 V)

(a) -0.417×10^{-3}, 70.9 μA (b) -0.417×10^{-3}, 50 μA
(c) -0.293×10^{-3}, 50 μA (d) -0.293×10^{-3}, 70.9 μA

Ans. (c)



Apply KVL in loop-1, we get

$$1_c = \beta L_B = \frac{\beta(V_{CC} - V_{BE})}{R_B + (1+\beta)R_E}$$

Stability factor $S(V_{BE}) = S_V = \dfrac{\partial I_c}{\partial V_{BE}} = \dfrac{-\beta}{R_B + (1+\beta)R_E}$

$$S_V = \frac{-100}{240 + 101 \times 1} = -0.293 \times 10^{-3}$$

$$\Delta I_C = \text{SV} \times \Delta V_{BE} = 49.8\ \mu\text{A} \cong 50\ \mu\text{A}$$

End of Solution

120. An amplifier without any feedback has midband gain of –1000 , lower 3 dB frequency f_1 = 5 kHz and upper 3 dB frequency f_2 = 50 kHz. If a voltage series negative feedback with feedback factor of –0.1 is used in the amplifier, then the lower and upper 3 dB frequencies of the resultant amplifier are respectively

(a) 4.94 Hz and 5.058 kHz
(b) 5.05 MHz and 49.50 MHz
(c) 49.50 kHz and 49.50 MHz
(d) 49.50 Hz and 5.05 MHz

Ans. (d)

Given: mindband gain A = –1000
feedback factor β = –0.1
f_L = 5 kHz
f_H = 50 kHz

$$\therefore \quad f_{Lf} = \frac{f_L}{1 + A\beta} = \frac{5}{1 + 1000 \times 0.1} = 49.5\,\text{Hz}$$

$$f_{Hf} = f_H(1 + A\beta) = 50 \times 101 = 5.05\ \text{MHz}$$

End of Solution

121. Consider the following statements regarding the LVDT :

1. The LVDT output is basically an amplitude modulated signal. There is a possibility of a mix-up between the modulation frequency and the carrier frequency when the displacement varies sinusoidally.
2. Linearity is good up to 10 mm.
3. Sensitivity is high, approximately 80 V/m.

Which of the above statements are not correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (b)

End of Solution

122. Consider the following statements regarding filled system thermometers :

1. In case of system failure, usually the entire unit needs to be replaced.
2. Capillary allows considerable separation between the point of measurement and the point of indication.

3. Complex design makes them expansive.

Which of the above statements are correct ?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (c)

End of Solution

123. Consider the following statements regarding transducers :

1. Eddy-current gauge is used to measure the displacement.
2. Pirani gauge is used for high pressure.
3. Wiedemann effect is used in transducers to measure the torque, force, displacement and level measurement.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)

End of Solution

124. Consider the following statements regarding electromagnetic flowmeter :

1. It is not suitable for metering corrosive acids, cement slurries, detergents, greasy and sticky fluids.
2. It can measure high flow rates.
3. The liquid has to be conducting (conductivity > 10^{-6} mho-cm); this requirement eliminates its use for all gases and for most of the hydrocarbons.

Which of the above statements is/are **not** correct?

(a) 3 only (b) 1 and 2
(c) 1 and 3 (d) 2 and 3

Ans. (b)

End of Solution

125. Consider the following statements regarding the vibrating element pressure transducer:

1. It generates an inherently digital signal which is amenable to its acquisition by the microprocessor-based instrumentation.
2. It is sensitive to temperature variation, shock and vibration.
3. The detectable pressure range is typically from 10 mm of Hg to 6000 psig (42 MPa) with a typical accuracy of 0.1% of the span.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1,2 and 3

Ans. (d)

End of Solution

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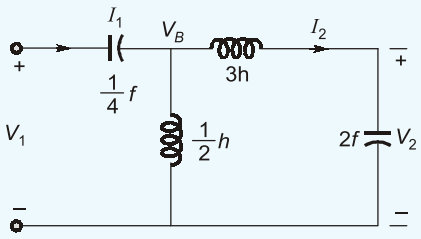
126. For the two-port network given below, what is the transfer impedance (Z_{21})?



(a) $\dfrac{s}{14s^2+3}$

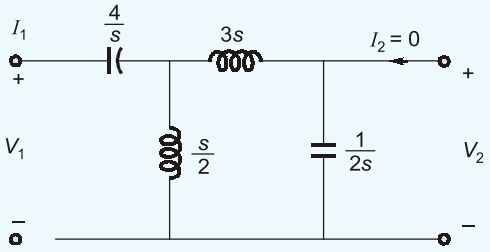
(b) $\dfrac{s^2}{14s^2+3}$

(c) $\dfrac{s}{14s^2+2}$

(d) $\dfrac{s^2}{14s^2+2}$

Ans. **(c)**

Given circuit,



$$Z_{21} = \left.\frac{V_2}{I_1}\right|_{I_2} = 0$$

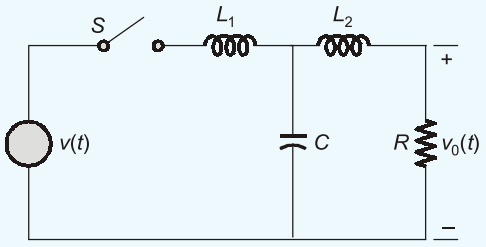
$$V_2 = \frac{I_1 \times 0.5s \times \frac{0.5}{s}}{3s + 0.5s + \frac{0.5}{s}}$$

$$\frac{V_2}{I_1} = \frac{(0.5 \times 0.5)s}{0.5s^2 + 3s^2 + 0.5} = \frac{0.25s}{3.5s^2 + 0.5}$$

$\therefore$ $Z_{21} = \dfrac{s}{14s^2+2}$ option (c) is correct

End of Solution

127. For the network shown below, what is the voltage $v_0(t)$ across the resistor R, the switch closes at $t = 0$, and assume all initial conditions are zero at $t = 0$?

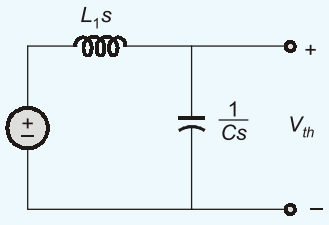


(a) $L^{-1}\left\{\dfrac{RV(s)\left(\dfrac{1}{sC}\right)}{(R+sL_2)\left(sL_1+\dfrac{1}{sC}\right)+L_1/C}\right\}$ (b) $L^{-1}\left\{\dfrac{RV(s)(sC)}{(R+sL_2)\left(sL_1+\dfrac{1}{sC}\right)+L_1/C}\right\}$

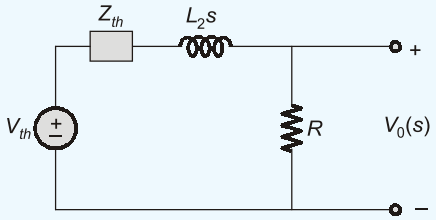
(c) $L^{-1}\left\{\dfrac{RV(s)\left(\dfrac{1}{sC}\right)}{(R+sL_2)\left(sL_1+\dfrac{1}{sC}\right)+L_2/C}\right\}$ (d) $L^{-1}\left\{\dfrac{V(s)\left(\dfrac{1}{sC}\right)}{(R+sL_2)\left(sL_1+\dfrac{1}{sC}\right)+L_1/C}\right\}$

Ans. (b)

$$V_{th}=\frac{V(s)\times\dfrac{1}{sC}}{L_1s+\dfrac{1}{Cs}}$$



$$Z_{th}=\frac{L_1s\cdot\dfrac{1}{Cs}}{L_1s+\dfrac{1}{Cs}}$$



$$V_0(s)=\frac{V_{th}\cdot R}{Z_{th}+L_2s+R}=\frac{\dfrac{V(s)\cdot\dfrac{1}{Cs}\cdot R}{L_1s+\dfrac{1}{Cs}}}{\dfrac{L_1s\cdot\dfrac{1}{Cs}}{L_1s+\dfrac{1}{Cs}}+L_2s+R}$$

$$\therefore\quad V_0(s)=\frac{RV(s)\cdot\dfrac{1}{Cs}}{\dfrac{L_1}{C}+(L_2s+R)\left(L_1s+\dfrac{1}{Cs}\right)}$$

$$\therefore\quad V_0(t)=L^{-1}\left[\frac{RV(s)\cdot\dfrac{1}{Cs}}{(R+sL_2)\left(sL_1+\dfrac{1}{sC}\right)+\dfrac{L_1}{C}}\right]$$

$\therefore$ Option (b)

End of Solution

128. Consider the following statements regarding the semiconductor diode:
1. PIV rating for the silicon is near about 1000 V.
2. Maximum PIV rating for germanium is closer to 200 V.
3. Germanium can be used for applications in which the temperature may rise to about 200°C.

Which of the above statements are not correct?
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (c)

	Si	Ge
Maximum PIV	1000 V	400 V
Maximum temperature	200°C	100°C

End of Solution

129. Consider the following statements regarding the semiconductor diode :
1. Ac or dynamic resistance can be defined as $r_d = \frac{26\text{ mV}}{I_d}$.
2. The lower the Q-point of operation, the lower is the ac resistance.
3. As with the de and ac resistance levels, the lower the level of currents used to determine the average resistance, the higher is the resistance level.

Which of the above statements are correct?
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (b)
The lower the Q-point of operation, higher is the ac resistance.
Alternate:
Since, $r_d = \frac{V_T}{I}$
if $1\downarrow = r_d\uparrow$
Therefore, option 1 and 3 are correct and 2 is wrong.

End of Solution

130. Consider the following statements regarding the BJT :
1. In the de mode, the levels of I_E and I_C due to majority carriers are related by a quantity called alpha and defined by $\alpha_{dc} = \frac{\Delta I_C}{\Delta I_E}$.
2. In the case of ac mode, alpha is formally called the common-base, forward current amplification factor.
3. For linear (least distortion) amplification purpose, cutoff for the common-emitter configuration will be defined by $I_C = I_{CEO}$.

Which of the above statements are correct?
(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (c)

End of Solution

131. For the typical transistor amplifier in the active region, V_{CE} is usually about

(a) 7% to 50% of V_{CC} (b) 15% to 50% of V_{CC}

(c) 20% to 70% of V_{CC} (d) 25% to 75% of V_{CC}

Ans. **(d)**

For the typical transistor amplifier in the active region, V_{CE} is usually about 25% to 75% of V_{CC}.

End of Solution

132. Consider the following statements regarding the BJT :

1. β decreases with decrease in temperature.
2. $|V_{BE}|$ decreases about 2.5 mV per degree Celsius increase in temperature.
3. Reverse saturation current doubles in value for every 20°C increase in temperature.

Which of the above statements is/are **not** correct?

(a) 1 only (b) 1 and 2

(c) 1 and 3 (d) 2 and 3

Ans. **(*)**

$\Rightarrow$ β increases with increase in temp as we can say β decreases with decrease in temp.

$\Rightarrow$ $\dfrac{\Delta V_{BE}}{\Delta T} = -2.5$ mV/°C

$\Rightarrow$ Reverse saturation current doubles for every 10°C rise in temp.

Alternate:

If Temp$\downarrow$ $\Rightarrow$ $\beta\downarrow$

Temp$\uparrow$ $\Rightarrow$ $V_{BE} \downarrow$ 2.5 mV

Hence, statement (1) and statement (2) are correct.

End of Solution

133. A non-uniform electric field is given by $E = ya_x + xa_y + 2ya_z$ V/m. A charge of 2C is transferred from point $A(1, 0, 3)$ to point $B(2, 1, 3)$ along the straight line from point A to point B. What is the work done?

(a) –1 J (b) –2 J

(c) –3 J (d) –4 J

Ans. **(d)**

$$\text{Work done, } W = -q\int_i^t \bar{E}\cdot\overline{dl}\,; \quad \bar{E} = y\hat{a}_x + x\hat{a}_y + 2y\hat{a}_z$$

$$\overline{dl} = dx\hat{a}_x + dy\hat{a}_y + dz\hat{a}_z$$

$$\bar{E}\cdot\overline{dl} = ydx + xdy + 2ydz$$

$\Rightarrow$ $$W = -q\int_A^B (ydx + xdy + 2ydz)$$

Here, $z = 3$ plane $\Rightarrow$ $dz = 0$

$\therefore$ $$W = -q\int_A^B ydx + xdy = -2\int_{1,0}^{2,1} ydx + xdy$$

$\because$ The path is a straight line

$$\therefore \quad \text{slope; } m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1-0}{2-1} = 1$$

so, $y - y_1 = m(x - x_1)$

$\Rightarrow \quad y - 0 = (x - 1)$

$\Rightarrow \quad y = (x - 1)$

$\Rightarrow \quad dy = dx$

$$\therefore \quad W = -2\int_{x=1}^{2} (x-1)dx + xdx$$

$$\Rightarrow \quad W = -2\left[\int_{x=1}^{2} 2x\,dx - \int_{x=1}^{2} dx\right]$$

$$\Rightarrow \quad W = -2\left[\frac{2x^2}{2}\Big|_1^2 - x\Big|_1^2\right] = -2[3 - 1] = -4\text{J}$$

End of Solution

134. The differential magnetic field at any point is proportional to the product of the current, differential length and the sine of the angle between the element and the line joining to that point. This is known as

(a) Coulomb's law
(b) Ampere's Circuital Law
(c) Gauss's law
(d) Biot-Savart's Law

Ans. (d)

Biot-savart law,

$$d\bar{H} = \frac{i\bar{dl} \times \hat{a}_r}{4\pi r^2} \text{ A/m}$$

End of Solution

135. A potential difference of 10 V is maintained across the ends of a copper wire 2 m in length. If the mean time between collisions is 2.7×10^{-4}s, then what is the drift velocity of the free electrons?

(a) $33.23 \times 10^{-2}\overrightarrow{a_z}$ m/s
(b) $42.12 \times 10^{-4}\overrightarrow{a_z}$ m/s
(c) $23.74 \times 10^{-3}\overrightarrow{a_z}$ m/s
(d) $20.74 \times 10^{-2}\overrightarrow{a_z}$ m/s

Ans. (c)

$\tau = 2.7 \times 10^{-14}$s

$l = 2$ m, $V = 10$ V

$$E = \frac{V}{l} = \frac{10}{2} = 5 \text{ V/m}$$

$$\mu = \frac{e\tau}{m} \qquad v_d = \frac{e\tau}{m} \cdot E$$

$$= nqe\frac{\tau}{m} = \frac{1.6\times10^{-19}\times2.7\times10^{-14}\times5}{9.1\times10^{-31}}$$

drift velocity, $v_d = 23.74\times10^{-3}\overrightarrow{a_z}$ m/s

End of Solution

136. What are the input and output impedances respectively with feedback for current series feedback having $A = -200$, $R_i = 15\ k\Omega$, $R_0 = 25\ k\Omega$ for feedback factor of -0.25?

(a) 0.76 kΩ and 1.27 kΩ (b) 0.76 MΩ and 1.27 MΩ

(c) 765 Ω and 1275 Ω (d) 7.65 MΩ and 12.75 MΩ

Ans. (b)

Given: $A = -200$; $R_i = 15\ k\Omega$, $R_0 = 25\ k\Omega$, $\beta = -0.25$

From the given information, $1 + A\beta = 1 + 0.25 \times 200 = 51$

For the current series feedback, both input and output impedance increases.

$$R_{if} = R_i(1 + A\beta) = 15 * 51 = 765\ k\Omega$$

$$R_{of} = R_0(1 + A\beta) = 25 \times 51 = 1.275\ M\Omega$$

End of Solution

137. Consider the following statements:

1. In the gated S-R latch, for the $S = R = 0$, the latch output does not change.
2. In J-K flip-flop, during the interval $J = 1$, $K = 0$ and $E = 0$, flip-flop will be reset.
3. Latches and flip-flops both are basically the bistable elements.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only

(c) 1, 2 and 3 (d) 2 and 3 only

Ans. (d)

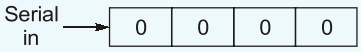
End of Solution

138. In a 4-bit serial in serial out (shift right mode) shift register using D flip-flops (negative edge triggered) all the flip-flops initially are in reset condition, i.e. $Q_3Q_2Q_1Q_0 = 0000$. The number of negative edges required to store the binary bit 1110 are

(a) 2 (b) 3

(c) 4 (d) 5

Ans. (b)

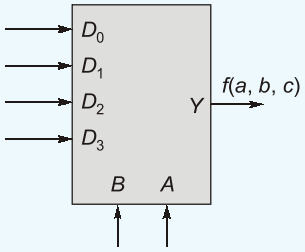


Clk	Input	Q_3	Q_2	Q_1	Q_0
0	–	0	0	0	0
1	1	1	0	0	0
2	1	1	1	0	0
3	1	1	1	1	0

∴ Three clock pulses required.

End of Solution

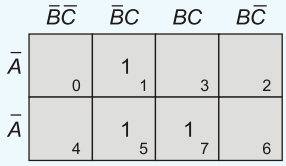
139. Function $f(a,b,c)=ab+\bar{b}c$ is implemented using 4 : 1 multiplexer. If a and b are considered as select lines and 'c' as an input to multiplexer, then what are the values of D_0, D_1, D_2, D_3?



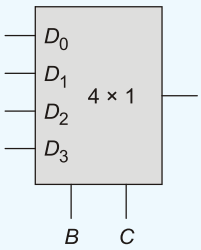
(a) $D_0 = 1,\ D_1 = c,\ D_2 = 0,\ D_3 = c$ (b) $D_0 = 1, D_1 = 1, D_2 = \bar{c}, D_3 = c$

(c) $D_0 = c,\ D_1 = 1,\ D_2 = c,\ D_3 = 1$ (d) $D_0 = c,\ D_1 = 0,\ D_2 = c,\ D_3 = 1$

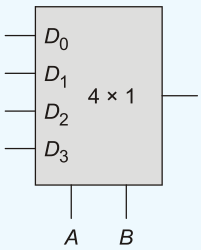
Ans. (c)



$f(A, B, C) = \Sigma m(1, 5, 6, 7)$



	D_0	D_1	D_2	D_3
$\bar{A}$	0	1	2	3
A	4	⑤	⑥	⑦
	0	1	A	A



	D_0	D_1	D_2	D_3
$\bar{C}$	0	2	4	⑥
C	①	3	⑤	⑦
	C	0	C	1

Hence, option (c) is correct answer.

End of Solution

140. Consider the following statements regarding the BJT and FET:

1. BJT is a voltage-controlled device and FET is a current-controlled device.
2. In both BJT and FET, the output current is the controlled variable.
3. Due to high input characteristics of FETs, the ac equivalent model is somewhat complex than that employed for the BJTs.

Which of the above statements is/are not correct?

(a) 1 only (b) 1 and 2

(c) 1 and 3 (d) 2 and 3

Ans. (c)

⇒ BJT is current controlled device whereas FET is voltage controlled device.

⇒ In both BJT and FET output current is controlled variable.

⇒ FET ac equivalent model is simpler than BJT.

End of Solution

141. What are the values of voltage gain, input and output impedances respective with voltage series feedback having
A (gain without feedback) = –100,
R_i (input impedance without feedback) = 10 kΩ,
R_0 (input impedance without feedback) = 20 kΩ,
β (feedback) = –0.1?

(a) –3.03, 100 kΩ, 2.02 kΩ
(b) –9.09, 100 kΩ, 2.02 kΩ
(c) –3.03, 110 kΩ, 1.82 kΩ
(d) –9.09, 110 kΩ, 1.82 kΩ

Ans. (d)

For the voltage series feedback, input impedance increases and output impedance decreases.

$$R_{if} = R_i(1 + A\beta) = 11 \times (1 + 0.1 \times 100) = 110\ \text{k}\Omega$$

$$R_{of} = \frac{R_0}{(1+A\beta)} = \frac{20}{(1+0.1\times 100)} = 1.82\ \text{k}\Omega$$

End of Solution

142. The frequency of practical FET Colpitts oscillator can be found by

(a) $f_0 = \dfrac{1}{2\pi\sqrt{R_1C_1R_2C_2}}$
(b) $f_0 = \dfrac{1}{2\pi CL_{eq}}$
(c) $f_0 = \dfrac{1}{2\pi\sqrt{RC_{eq}}}$
(d) $f_0 = \dfrac{1}{2\pi\sqrt{LC_{eq}}}$

Ans. (d)

The frequency of practical FET colpitts oscillator can be found by

$$f_0 = \frac{1}{2\pi\sqrt{LC_{eq}}}$$

End of Solution

143. Consider the following statements.
1. Smoke test is a non-exhaustive test to ensure that the crucial requirements for the product are functioning.
2. Sanity testing is superficial testing performed to test the durability of the product.
3. Scalability test is used to test the performance aspects of the product after integration.

Which of the above statements are not correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (c)

End of Solution

144. Consider the following statements regarding the VLSI design:
1. Parallelism and pipelining have been effective ways to reduce power consumption.
2. Replacing a single functional unit with an N-stage pipelined unit reduces the amount of logic in a clock cycle at the expense of more registers.

3. When leakage is unimportant, parallelism offers a slight edge because the multiplexer has less overhead than the pipeline registers.

Which of the above statements are correct?

(a) 1 and 2 only (b) 2 and 3 only
(c) 1 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

145. Consider the following statements:

1. The genera] formula for the minimum possible sampling rate for a bandpass signal can be recovered from the samples.

$$f_s = \frac{2f_h}{\text{Largest integer not exceeding } \frac{f_b}{f_h - f_l}}$$

2. If we sample at a rate higher than twice the highest frequency, the aliases do not overlap and the original signal can be recovered.
3. The absolute minimum sampling rate in most favourable situation is twice the highest frequency, not the bandwidth of the signal.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (d)

End of Solution

146. The recursive system described by a linear constant-coefficient difference equation is

(a) linear and time invariant (b) linear and time variant
(c) non-linear and time invariant (d) non-linear and time variant

Ans. (a)

End of Solution

147. What is the input signal $x(n)$ that will generate the output $y(n) = \{1, 5, 10, 11, 8\}$ for a system with impulse response $h(n) = \{1, 2, 1\}$?

(a) {1, 2, 1} (b) {3, 3, 1}
(c) {1, 3, 3} (d) {1, 3, 1}

Ans. (*)

All options are wrong.

End of Solution

148. The convolution sum is used to give the response of

(a) linear systems only (b) time invariant systems only
(c) linear time invariant systems (d) causal systems only

Ans. (c)

End of Solution

149. If $x(n)$ is a periodic signal with fundamental period N and takes infinite values, then it is

(a) an energy signal only
(b) a power signal only
(c) neither energy signal nor power signal
(d) both energy and power signals

Ans. (c)

End of Solution

150. What is the particular solution of the difference equation

$$y(n)=\frac{5}{6}y(n-1)-\frac{1}{6}y(n-2)+x(n)$$

when the forcing function $x(n) = 2^n$, $n \geq 0$ and zero elsewhere?

(a) $y_p(n) = (-8)2^n$, $n \geq 0$
(b) $y_p(n) = (192/5)2^n$, $n \geq 0$
(c) $y_p(n) = (8/5)2^n$, $n \geq 0$
(d) $y_p(n) = (-8/5)2^n$, $n \geq 0$

Ans. (c)

By applying ZT on given difference equation

$$Y(z)=\frac{5}{6}z^{-1}Y(z)-\frac{1}{6}z^{-2}Y(z)+X(z)$$

$$\Rightarrow \quad \frac{Y(z)}{X(z)}=\frac{1}{1-\frac{5}{6}z^{-1}+\frac{1}{6}z^{-2}}$$

$$\Rightarrow \quad Y(z)=\frac{1}{\left(1-\frac{5}{6}z^{-1}+\frac{1}{6}z^{-2}\right)}\cdot\frac{1}{\left(1-2z^{-1}\right)}$$

$$=\frac{1}{\left(1-\frac{1}{3}z^{-1}\right)\left(1-\frac{1}{2}z^{-1}\right)(1-2z^{-1})}=\frac{A}{1-2z^{-1}}+\frac{B}{1-\frac{1}{3}z^{-1}}+\frac{C}{1-\frac{1}{2}z^{-1}}$$

$$\left[\because A=\frac{1}{\left(1-\frac{1}{3}\times\frac{1}{2}\right)\left(1-\frac{1}{2}\times\frac{1}{2}\right)}=\frac{1}{\frac{5}{6}\times\frac{3}{4}}=\frac{8}{5}\right]$$

$$\Rightarrow \quad Y(z)=\frac{8/5}{1-2z^{-1}}+\frac{B}{1-\frac{1}{3}z^{-1}}+\frac{C}{1-\frac{1}{2}z^{-1}}$$

$$\Rightarrow \quad y(n)=\frac{8}{5}2^n\cdot u(n)+B\left(\frac{1}{3}\right)^n u(n)+C\left(\frac{1}{2}\right)^n u(n)$$

$$\Rightarrow \quad y_p(n)=\text{Particular solution}=\frac{8}{5}(2)^n u(n)$$

End of Solution