CLASS TEST

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COMMUNICATIONS

ELECTRONICS ENGINEERING

Date of Test : 22/07/2026

ANSWER KEY

1.	(b)	7.	(d)	13.	(c)	19.	(a)	25.	(b)
2.	(b)	8.	(b)	14.	(b)	20.	(a)	26.	(a)
3.	(b)	9.	(d)	15.	(c)	21.	(a)	27.	(a)
4.	(c)	10.	(b)	16.	(d)	22.	(a)	28.	(c)
5.	(d)	11.	(c)	17.	(b)	23.	(b)	29.	(b)
6.	(a)	12.	(b)	18.	(d)	24.	(a)	30.	(b)

Detailed Explanations

1. (b)

The instantaneous phase of the modulated signal,

$$\theta_i(t) = 2\pi f_c t + 3\sin(1000\pi t)$$

$$\text{Phase deviation, } \phi(t) = 3\sin(1000\pi t)$$

$$\therefore \quad \text{Peak frequency deviation } \Delta f_{max} = \left|\frac{1}{2\pi}\frac{d}{dt}\phi(t)\right|_{max}$$

$$= \left|\frac{1}{2\pi} \times 3 \times 1000\pi \cos(1000\pi t)\right|_{max}$$

$$= \frac{3 \times 1000}{2\pi} \times \pi$$

$$= 1.5 \text{ kHz}$$

2. (b)

Given, $$2[\Delta f] = 150 \text{ kHz} = \text{Carrier swing}$$

$$\therefore \quad \Delta f = 75 \text{ kHz}$$

$$\beta = 5$$

$$\text{For FM, } \beta = \frac{\Delta f}{f_m}$$

$$\therefore \quad f_m = \frac{\Delta f}{\beta} = \frac{75 \text{ kHz}}{5}$$

Frequency of modulating signal, $f_m = 15$ kHz

3. (b)

Block-A $\rightarrow$ Limiter : It is used to remove the amplitude variations in the FM signal due to noise and keep the amplitude of the signal in the FM receiver at a constant value.

Block-B $\rightarrow$ Demodulator : It demodulates the received signal and recovers the original information signal from the modulated carrier wave.

Block-C $\rightarrow$ De-emphasis circuit : It compensates for the pre-emphasis that was applied to the signal at the transmitter.

4. (c)

$$m_1 = 0.6, \quad m_2 = 0.3$$

$$m_t = \sqrt{m_1^2 + m_2^2}$$

$$= \sqrt{(0.6)^2 + (0.3)^2}$$

$$m_t = 0.671$$

$$\text{Power efficiency } \eta = \frac{m_t^2}{2 + m_t^2} \times 100$$

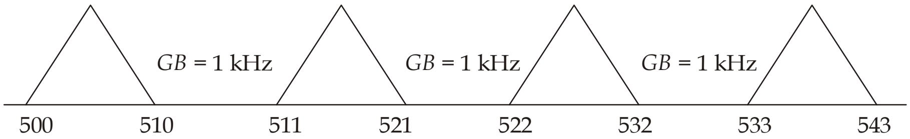
$$\eta = 18.38\%$$

5. (d)

Given that each message bandlimited to 5 kHz

$$\therefore \quad f_m = 5 \text{ kHz}$$

The DSB-SC modulated signal will occupy a bandwidth of $2f_m$ = 10 kHz. The spectrum of the multiplexed signal with a guard band of 1 kHz between the modulated signals is shown as below:



$\therefore$ Highest frequency occupied by the multiplexed signal is 543 kHz.

6. (a)

The purpose of the limiter is to provide a constant level of the signal to the FM demodulator, thus reducing the effect of signal level (amplitude) changes in the output.

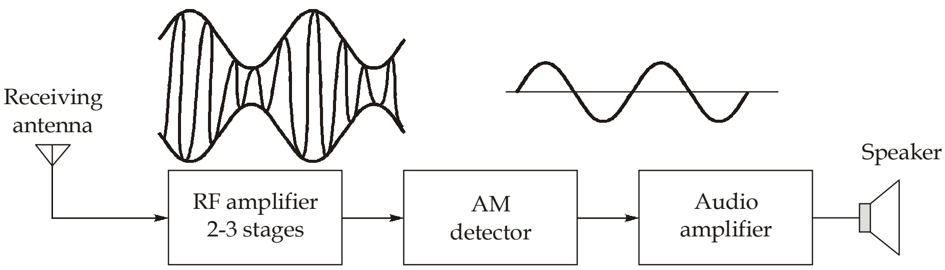
7. (d)

Given,
$$P_{VSB} = 0.75 \text{ kW}$$
$$\mu = 75\% = 0.75$$
$$F = 30\% = 0.3$$
$$P_{VSB} = \frac{\mu^2}{4}P_c + F\left(\frac{\mu^2}{4}P_c\right)$$
$$0.75 \times 10^3 = \frac{(0.75)^2}{4} \times P_c(1+0.3)$$
$$\therefore \quad P_c = 4.1 \text{ kW}$$

To transmit the same message using AM transmitter, the total required power is
$$P_t = P_c\left(1+\frac{\mu^2}{2}\right) = 4.1\left(1+\frac{0.75^2}{2}\right) = 5.25 \text{ kW}$$

8. (b)

Block Diagram of TRF Receiver:



9. (d)

In a diode detector circuit, if the AC load for the diode is very much smaller than the DC load, it can result in negative peak clipping.

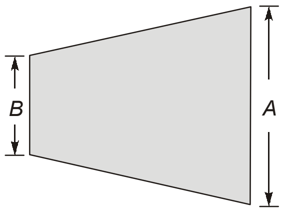
10. (b)

For FM signal,
$$\beta = \text{Maximum phase deviation}$$
$$= 3 \text{ radians}$$

Note : Unit of modulation index of a single-tone FM signal is radian by default.

11. (c)

When the sinusoidal message signal is applied to the X-plates and the undermodulated AM signal is applied to Y-plates, the standard X - Y plot of a CRO is as follows:



The modulation index of the AM signal in terms of A and B can be given by,

$$\mu = \frac{A-B}{A+B}$$

For plot given in option (a),

$$\mu = \frac{10-2}{10+2} = \frac{8}{12} = 0.67$$

For plot given in option (b),

$$\mu = \frac{8-2}{8+2} = \frac{6}{10} = 0.60$$

For plot given in option (c),

$$\mu = \frac{18-2}{18+2} = \frac{16}{20} = 0.80$$

For plot given in option (d),

$$\mu = \frac{15-7}{15+7} = \frac{8}{22} = 0.36$$

So, the plot given in option (c) is correct.

12. (b)

The standard AM signal,

$$s(t) = A_c[1 + k_a m(t)] \cos\omega_c t$$

Sideband component,

$$s_1(t) = k_a A_c m(t) \cos\omega_c t$$

$$= \frac{k_a A_c}{2}\left[e^{j\omega_c t} + e^{-j\omega_c t}\right] m(t)$$

Sideband power,

$$P_{SB} = \int_{-\infty}^{\infty} \left(\frac{k_a A_c}{2}\right)^2 |m(t)|^2 dt + \int_{-\infty}^{\infty} \left(\frac{k_a A_c}{2}\right)^2 |m(t)|^2 dt$$

$$= 2\left(\frac{k_a A_c}{2}\right)^2 P_m = \frac{k_a^2 A_c^2}{2} P_m$$

$$= k_a^2 P_c P_m \qquad \because P_c = \frac{A_c^2}{2}$$

Total power,

$$P_t = P_c + P_{SB} = P_c\left[1 + k_a^2 P_m\right]$$

Transmission efficiency,

$$\eta = \frac{P_{SB}}{P_t} \times 100$$

$$= \frac{P_c(k_a^2 P_m)}{P_c(1 + k_a^2 P_m)} \times 100 = \frac{k_a^2 P_m}{1 + k_a^2 P_m} \times 100$$

$$= \frac{(0.1)^2\,(10)}{1 + (0.1)^2\,(10)} \times 100 = \frac{0.1}{1.1} \times 100 = 9.09\%$$

13. (c)

$$y(t) = x(t) + x(t-2)$$
$$Y(\omega) = X(\omega) + X(\omega)e^{-2j\omega}$$
$$H(\omega) = \frac{Y(\omega)}{X(\omega)} = 1 + e^{-2j\omega}$$

We know that, $$S_Y(\omega) = |H(\omega)|^2 S_X(\omega)$$

Where, $$|H(\omega)|^2 = 2(1 + \cos 2\omega)$$

and $$S_X(\omega) = FT\left|R_X(\tau)\right| = FT\left|e^{-|\tau|}\right|$$
$$= \frac{2}{1^2 + \omega^2} = \frac{2}{1+\omega^2}$$

$\therefore$ $$S_Y(\omega) = 2(1+\cos 2\omega)\left[\frac{2}{1+\omega^2}\right] = \frac{4(1+\cos 2\omega)}{1+\omega^2}$$

14. (b)

$$\text{Coding efficiency} = \frac{\text{Minimum number of bits required (including sign bit)}}{\text{Actual number of bits used (including sign bit)}}$$

Minimum dynamic range required is 46 dB.

$$(DR)_{\text{dB}} = 20\log_{10} DR$$

$\therefore$ $$46 = 20\log_{10} DR$$
$$DR = 199.5$$

and $$DR = \frac{V_{\max}}{V_{\min}} = 2^n - 1$$

$\therefore$ $$2^n - 1 \geq 199.5$$
$$n \geq \log_2 200.5 = 7.647$$

$\therefore$ $$n = 8 \text{ bits}$$

$\therefore$ $$\text{Coding efficiency} = \frac{7.647+1}{8+1} \times 100 = 96.08\%$$

15. (c)

$$m(t) = \cos(2\pi f_m t) + 2\sin(2\pi f_m t) \;\; ; f_m = 2 \text{ kHz}$$
$$c(t) = 100\cos(2\pi f_c t) \; ; f_c = 100 \text{ kHz}$$

The expression for the standard lower sideband SSB-AM signal can be given as,

$$s(t) = \frac{1}{2}\left(A_c m(t)\cos\omega_c t + A_c \hat{m}(t)\sin\omega_c t\right)$$

Here, Hilbert Transform of $m(t)$,

$$\hat{m}(t) = \sin(2\pi f_m t) - 2\cos(2\pi f_m t)$$

So, $$s(t) = \frac{A_c}{2}\left[\cos\omega_c t\left(\cos\omega_m t + 2\sin\omega_m t\right) + \sin\omega_c t\left(\sin\omega_m t - 2\cos\omega_m t\right)\right]$$

$$= \frac{A_c}{2}\left[\left(\cos\omega_c t\,\cos\omega_m t + \sin\omega_c t\,\sin\omega_m t\right) + 2\left(\cos\omega_c t\,\sin\omega_m t - \sin\omega_c t\,\cos\omega_m t\right)\right]$$

$$= \frac{A_c}{2}\left[\cos\left(\omega_c - \omega_m\right)t - 2\sin\left(\omega_c - \omega_m\right)t\right]$$

With given values,

$$s(t) = 50\cos[2\pi(98000t)] - 100\sin[2\pi(98000t)]$$

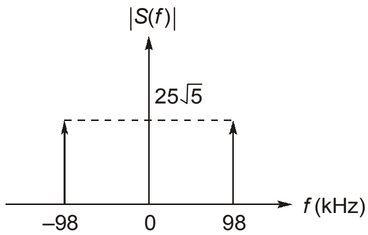
By applying Fourier transform, we get,

$$S(f) = 25[\delta(f-98k)+\delta(f+98k)] - \frac{50}{j}[\delta(f-98k)-\delta(f+98k)]$$
$$= (25 + j50)\,\delta(f - 98k) + (25 - j50)\,\delta(f + 98k)$$

For magnitude spectrum,

$$|S(f)| = \sqrt{(25)^2+(50)^2}[\delta(f-98k)+\delta(f+98k)]$$
$$= 25\sqrt{5}[\delta(f-98k)+\delta(f+98k)]$$

By plotting, we get,



16. (d)

For delta modulator, the signal to quantization noise ratio is given as

$$\text{SNR} = \frac{3}{8\pi^2}\left[\frac{f_s}{f_m}\right]^3$$

$$R_s = 128 \text{ kbps}$$
$$nf_s = 128 \text{ kbps}$$
$$1 \times f_s = 128 \text{ kbps} \qquad \text{[For Delta modulation, } n = 1 \text{ bit/sample]}$$

$\therefore$ $$f_s = 128 \text{ kHz}$$

and $$f_m = 8 \text{ kHz}$$

$$\text{SNR} = \frac{3}{8\pi^2}\left[\frac{128}{8}\right]^3 = 155.629$$
$$(\text{SNR})_{\text{dB}} = 10\log_{10}[155.629]$$
$$(\text{SNR})_{\text{dB}} = 21.92 \text{ dB}$$

17. (b)

$$C = B\log_2\left[1+\frac{S}{N}\right] \Rightarrow C \propto B$$

Since C is the channel capacity representing the maximum possible information transmitted per second and B is the channel bandwidth in Hz. Hence, a wide band signal would be required for transmitting large amount of information in small amount of time.

18. (d)

DPCM works by encoding the difference between successive samples. Hence, the performance of the DPCM system improves as the correlation between the adjacent samples increases.

19. (a)

We know that, $$M_2 = \frac{M_1}{\log_2 M} = \frac{M_1}{\log_2(8)} = \frac{M_1}{3}$$

$\therefore$ $$\frac{M_1}{M_2} = 3$$

20. (a)

$$R_b = 10 \text{ kbps}$$

$$\frac{N_0}{2} = 10^{-11} \frac{\text{W}}{\text{Hz}}$$

Given, $$P_e = Q(\sqrt{20}) \quad \text{...(i)}$$

for PSK, $$P_e = Q\left[\sqrt{\frac{A^2 T_b}{N_0}}\right] \quad \text{..(ii)}$$

$$T_b = \frac{1}{R_b}$$

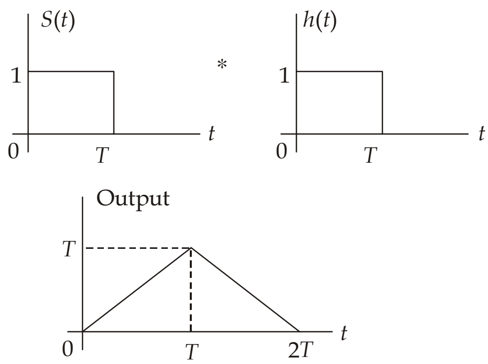
from (i) and (ii)

$$\frac{A^2 T_b}{N_0} = 20$$

$$A^2 = 20 \times \frac{N_0}{T_b}$$

$$A = \sqrt{20 \times 2 \times 10^{-11} \times 10 \times 10^3} = 2 \text{ mV}$$

21. (a)



22. (a)

We have, $$\int_0^1 \int_0^1 K(x^2 + y^2)dxdy = 1$$

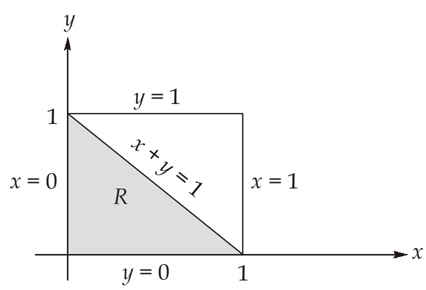
$$\int_0^1 K\left(\frac{x^3}{3} + x \cdot y^2\right)\Bigg|_0^1 dy = 1$$

$$\int_0^1 K\left[\frac{1}{3} + y^2\right] dy = 1$$

$$K\left[\frac{y}{3} + \frac{y^3}{3}\right]_0^1 = 1$$

$$K\left[\frac{1}{3} + \frac{1}{3}\right] = 1$$

$$K = \frac{3}{2}$$



$$P(X+Y>1) = 1 - P(X+Y \le 1)$$

$$= 1-\left[\int_0^1\int_0^{1-x}\frac{3}{2}\left[x^2+y^2\right]dy\,dx\right]$$

$$= 1-\frac{3}{2}\left[\int_0^1\int_0^{1-x}x^2 dy\,dx+\int_0^1\int_0^{1-x}y^2 dy\,dx\right]$$

$$= 1-\frac{3}{2}\left[\int_0^1 x^2[1-x]dx+\int_0^1 \frac{y^3}{3}\Bigg|_0^{1-x}dx\right]$$

$$= 1-\frac{3}{2}\left[\int_0^1 (x^2-x^3)dx+\int_0^1 \frac{1}{3}\left[(1-x)^3\right]dx\right]$$

$$= 1-\frac{3}{2}\int_0^1 (x^2-x^3)dx-\frac{1}{2}\int_0^1 (1-3x+3x^2-x^3)dx$$

$$= 1-\frac{3}{2}\left(\frac{x^3}{3}-\frac{x^4}{4}\Bigg|_0^1\right)-\frac{1}{2}\left[x-\frac{3x^2}{2}+\frac{3x^3}{3}-\frac{x^4}{4}\Bigg|_0^1\right]$$

$$= 1-\frac{3}{2}\left[\frac{1}{3}-\frac{1}{4}\right]-\frac{1}{2}\left[1-\frac{3}{2}+1-\frac{1}{4}\right]$$

$$= \frac{3}{4}$$

23. (b)

In an (n, k) linear block code, 'k' message bits are encoded into 'n' bits, where $n > k$. Hence, the coding efficiency of a (n, k) code can be given as,

$$\text{efficiency} = \frac{k}{n}\times 100\%$$

For a (5, 3) Hamming code,

$$\text{Efficiency} = \frac{3}{5}\times 100 = 60\%$$

24. (a)

$$\text{Spectral efficiency } \eta_s = \frac{R_T}{BW}$$

$$= \frac{1.152 \text{ Mbps}}{342 \text{ Kbps}} = 3.368$$

25. (b)

$$x(t) = \cos t-\sqrt{3}\sin t$$

$$= 2\left(\frac{\cos(t)}{2}-\frac{\sqrt{3}}{2}\sin t\right)$$

$$= 2(\cos t \cos(60°) - \sin(60°) \sin t)$$

$$= 2\cos(t + 60°)$$

Hilbert transform provides a phase shift of –90°.

Hilbert transform of $x(t)$

$$\hat{x}(t) = 2\cos(t + 60° - 90°)$$
$$= 2\cos(t - 30°)$$
$$= 2\sin(t - 30° + 90°)$$
$$= 2\sin(t + 60°)$$

26. (a)

Maximum phase deviation, $\phi_{max} = 2\pi \times 10^2 \left[\int m(t)\cdot dt\right]_{max}$

$\left(\int m(t)\cdot dt\right)_{max}$ is the area of message signal $m(t)$.

$$\left(\int m(t)\cdot dt\right)_{max} = 1\times 3 + \frac{1}{2}\times 1 = 3.5$$

Maximum phase deviation, $\phi_{max} = 2\pi \times 10^2(3.5)$

$$= 7\pi(100)$$
$$= 700\pi$$

27. (a)

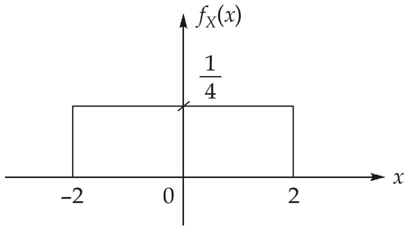
$$\mu_1 = 0.5$$
$$P_t = 11 \text{ kW}$$
$$P_t = P_c\left(1 + \frac{\mu_1^2}{2}\right)$$

When carrier is modulated by another sine wave of modulation index μ_2,

Radiated power, $P_t' = 11.8$ kW

$$\mu = \sqrt{\mu_1^2 + \mu_2^2}$$
$$P_t' = P_c\left(1 + \frac{\mu^2}{2}\right)$$
$$\frac{P_t}{P_t'} = \frac{\left(1 + \frac{\mu_1^2}{2}\right)}{\left(1 + \frac{\mu^2}{2}\right)}$$
$$\left(1 + \frac{\mu^2}{2}\right) = \left(1 + \frac{\mu_1^2}{2}\right)\frac{P_t'}{P_t}$$
$$\left(1 + \frac{\mu^2}{2}\right) = \left(1 + \frac{0.25}{2}\right)\frac{11.8}{11}$$
$$\frac{\mu^2}{2} = 0.2068$$
$$\mu = 0.643$$
$$\mu = \sqrt{\mu_1^2 + \mu_2^2} = 0.643$$
$$0.25 + \mu_2^2 = 0.413$$
$$\mu_2 = 0.404$$

28. (c)



$$\therefore \qquad E[X] = 0 \qquad \text{...No D.C. power is present.}$$

$$\text{Variance} = \frac{[2-(-2)]^2}{12} \quad i.e., \quad \frac{(a-b)^2}{12}$$

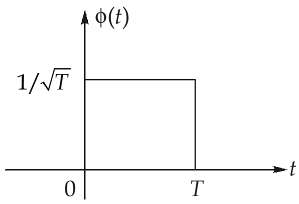
$$\sigma^2 = \frac{4}{3}$$

$$\therefore \qquad \text{Variance} = \text{Mean square value} = \frac{4}{3}$$

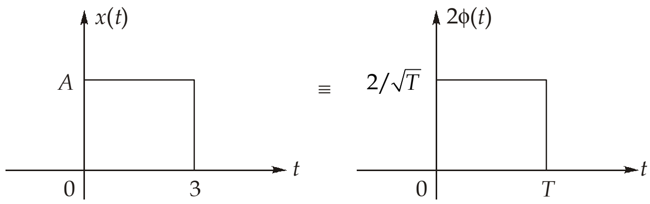
$$\text{Standard deviation} = \text{rms value} = \sqrt{\frac{4}{3}} = \frac{2}{\sqrt{3}}$$

29. (b)

For one dimension space, the orthonormal basis $\phi(t)$ can be assumed as



Given $\qquad x(t) = 2\phi(t)$



On comparing $\qquad A = \frac{2}{\sqrt{T}} = \frac{2}{\sqrt{3}}$

30. (b)

For continuous Random variable;

$$Y = aX + b$$

$$H(Y) = H(X) + \log_2 a$$

here, $\qquad a = 8$

$\therefore \qquad H(Y) = H(X) + 3$

Note: For discrete R.V. having

$$Y = aX + b$$

then $\qquad H(Y) = H(X)$

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