Branch: Electronics & Communication Engineering - SOLUTIONS

01. Ans: 24 (No range)

Sol: Given that F(x) = f(g(x))

$\Rightarrow F^1(x) = f^1(g(x)).\ g^1(x)$ ($\because$ by chain rule)

$\Rightarrow F^1(5) = f^1(g(5)).\ g^1(5)$

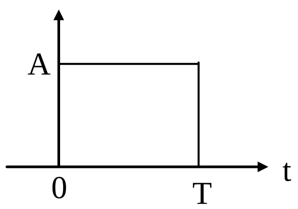
$\Rightarrow F^1(5) = f^1(-2)\ .6$

$\therefore F^1(5) = (4)(6) = 24$

02. Ans: (c)

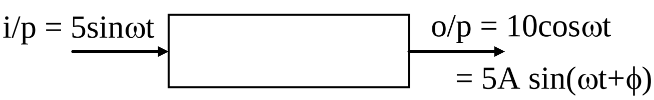
Sol: $E = A^2T$

$$\frac{S}{N} = \frac{2E}{N_0} = \frac{2A^2T}{N_0}$$



03. Ans: (d)

Sol:



$10\cos\omega t = 5A\sin(\omega t + \phi)$

$A = 2,\ \phi = 90^\circ$

If input = $10\cos\omega t$

output = $(10)(2)\cos(\omega t + 90^\circ)$

$= -20\sin\omega t$

04. Ans: (d)

Sol: We know that,

$P(A \cap B) \le$ min of $\{P(A), P(B)\}$

$\Rightarrow P(A \cap B) \le 0.25$ .... (1)

We have, $P(A \cup B) \le P(S)$

$\Rightarrow \{P(A) + P(B) - P(A \cap B)\} \le 1$

$\Rightarrow \{0.25 + 0.8 - P(A \cap B)\} \le 1$

$\Rightarrow 0.05 \le P(A \cap B)$ .... (2)

From (1) and (2), we have

$0.05 \le P(A \cap B) \le 0.25$

05. Ans: 113.09 (Range: 112.5 to 113.5)

Sol: $D_{max} = \frac{4\pi}{\lambda^2} A_e$

$$D_{max} = \frac{4\pi}{\lambda^2}(3\lambda)^2 = 36\pi = 113.09$$

06. Ans: 14.66 (14 to 15)

Sol: Transition capacitance

$$C_T = \frac{k}{(V_0 + V_R)^n}$$

When reverse bias voltage V_R is 4V,

C_T = 18 pF

$$\text{So, } 18\times10^{-12} = \frac{k}{(4.7)^{\frac{1}{3}}}$$

$$k = 18\times10^{-12}\times(4.7)^{\frac{1}{3}}$$

When reverse bias voltage V_R is 8V, let the capacitance be C,

$$C = \frac{k}{(8.7)^{\frac{1}{3}}}$$

$$C = \frac{18\times10^{-12}\times(4.7)^{\frac{1}{3}}}{(8.7)^{\frac{1}{3}}}$$

C = 14.66 pF

07. Ans: 388.488 (Range: 387 to 390)

Sol: $i(t) = 4 + 3\cos(10t-30^\circ) + 4\sin(10t+30^\circ)$

$= 4 + 3\cos(10t - 30^\circ) + 4\cos(10t + 30^\circ - 90^\circ)$

$= 4 + 3\cos(10t - 30^\circ) + 4\cos(10t - 60^\circ)$

$= 4 + 3\angle{-30^\circ} + 4\angle{-60^\circ}$

$= 4 + 3\cos30^\circ - j3\sin30^\circ + 4\cos60^\circ - j4\sin60^\circ$

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

$= 4 + 6.766\angle{-47.24°}$
$= 4 + 6.76\angle{-47.24}$
$i(t) = 4 + 6.76 \cos(10t - 47.24)$

$$I_{rms} = \sqrt{4^2 + \left(\frac{6.76}{\sqrt{2}}\right)^2}$$

$$= \sqrt{38.84}$$

Power dissipated in 10Ω is

$$P = I_{rms}^2 \times R = \left(\sqrt{38.84}\right)^2 \times 10$$

$= 38.84 \times 10$
$P = 388.4$ watts

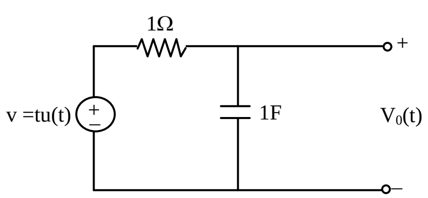
08. Ans: (b)

Sol: $E_{Fn} - E_{Fi} = KT \ln\left(\frac{N_D}{n_i}\right)$

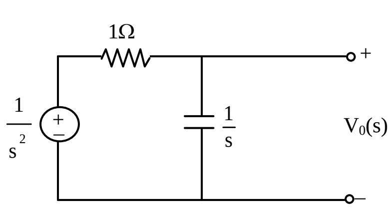
$$0.3 eV = 0.02586 \ln\left(\frac{N_D}{n_i}\right)$$

$N_D = 1.6379 \times 10^{15}/cm^3$
$J_n = nq\mu_n E$
$\simeq N_D q\mu_n E$
$\simeq 1.6379 \times 10^{15} \times 1.6 \times 10^{-19} \times 1300 \times 10$
$\simeq 3.407\ A/cm^2$
$= 3407 \times 10^{-3}\ A/cm^2$

09. Ans: (b)
Sol:



Converting into Laplace domain we get



$$V_0(s) = \frac{\frac{1}{s} \times \frac{1}{s^2}}{1 + \frac{1}{s}} = \frac{1}{s^3\left(\frac{s+1}{s}\right)}$$

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

$$V_0(s) = \frac{A}{s} + \frac{B}{s^2} + \frac{C}{s+1}$$

$$B = \left.\frac{1}{s+1}\right|_{s=0} = 1$$

$$A = \left.\frac{dB}{ds}\right|_{s=0} = \left.\frac{(s+1) \times 0 - 1}{(s+1)^2}\right|_{s=0} = -1$$

$$C = \left.\frac{1}{s^2}\right|_{s=-1} = 1$$

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

Apply inverse Laplace transform on both sides

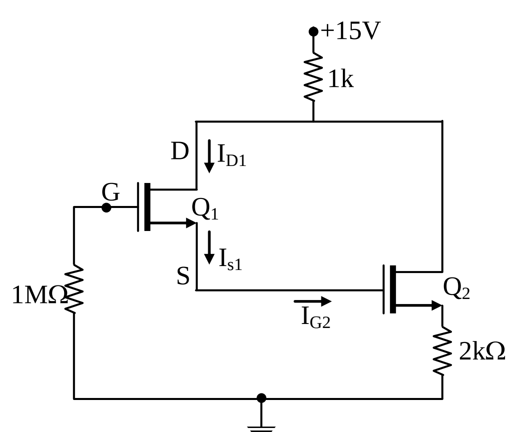
$V_0(t) = -u(t) + tu(t) + e^{-t} u(t)$
$V_0(t) = ((t - 1) + e^{-t})u(t),\ t > 0$

10. Ans: (d)

Sol: If $V_A > V_B$ all diodes are forward biased hence $R_{AB} = 0$. If $V_A < V_B$, D_1 D_3 RB & D_2 FB

$\therefore R_{AB} = 36\ \Omega + 18\ \Omega$
$= 54\ \Omega$

11. Ans: –4 (No range)
Sol:



Step(1): From the circuit,

$I_{S1} = I_{G2} = 0$ ___(1) [$\because I_G = 0$ in MOSFETs]

$\Rightarrow I_{D1} = I_{S1} = 0$ ___(2) [$\because I_D = I_S$ in MOSFETs

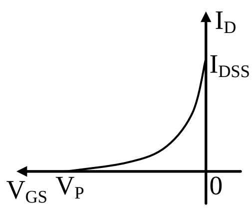
Step(2): Consider the transfer characteristics of a DMOSFET

Case (i): $I_D = I_{DSS}$ at $V_{GS} = 0$ ___(3)

Case (ii): $I_D = 0$ at $V_{GS} = V_P$ ____(4)

$\Rightarrow V_{GSQ1} = V_P = -4V$ ___(5)

$\because I_{D1} = 0$ in the ckt given



12. Ans: (b)

Sol: MOD-n ring counter is designed by using 'n' flipflops.

MOD-2n Johnson counter is designed by using 'n' flipflops.

So, MOD-8 ring counter requires 8 flipflops and MOD-8 Johnson counter requires 4 flipflops.

13. Ans: 8.33 (Range: 8 to 8.6)

Sol: According the concept of virtual ground

$V_1 = V_2$

$$\Rightarrow 5V = \frac{30kV_0}{30k + 20k}$$

$$\therefore V_0 = \frac{5V \times 50k}{30k} = 8.33V$$

14. Ans: 54.4 (54.2 to 54.6)

Sol: Given B = 4000 Hz, $S = 0.1\times10^{-3}W$

$N = 10^{-12}\times2\times4000 = 8\times10^{-9}$ W

$$\frac{S}{N} = 1.25\times10^4$$

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

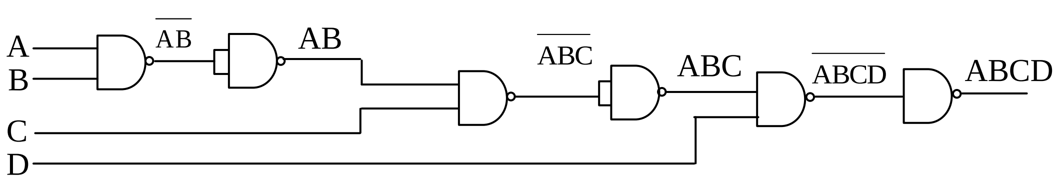
$C = 4000 \log_2 [1 + 1.25\times10^4]$

$= 54.4\times10^3$ bps

= 54.4 kbps

15. Ans: 6 (No range)

Sol: $Y = ABCD = \overline{\overline{\overline{\overline{\overline{\overline{A\,B}}}\,C}}\,D}$



$\therefore$ 6 NAND gates are required.

16. Ans: (a)

Sol: $|adjA| = |A|^{n-1}$

$\Rightarrow 1(12 - 12) - 11(4 - 6) + 3(4 - 6) = |A|^2$

$\Rightarrow 22 - 6 = |A|^2$

$\therefore |A| = \pm4$

17. Ans: 55 (Range: 54.90 to 55)

Sol: Compensator $D(s) = \dfrac{0.4s+1}{0.04s+1} = \dfrac{1+aTs}{1+Ts}$

aT = 0.4

T = 0.04

$\therefore$ a = 10

Maximum phase angle,

$$\phi_m = \sin^{-1}\left(\frac{a-1}{a+1}\right) = 55°$$

18. Ans: (c)

Sol: Given $y(n)-\frac{1}{4}y(n-1)=x(n)$

Apply z transform

$$Y(z)-\frac{1}{4}z^{-1}Y(z)=X(z)$$

$$Y(z)=\frac{X(z)}{1-\frac{1}{4}z^{-1}}$$

$x(n)=\delta(n-1)$

$$X(z)=z^{-1}$$

$$Y(z)=\frac{z^{-1}}{1-\frac{1}{4}z^{-1}}$$

Apply inverse z transform

$$\left(\frac{1}{4}\right)^n u(n)\leftrightarrow\frac{1}{1-\frac{1}{4}z^{-1}}$$

From time shifting property

$$\left(\frac{1}{4}\right)^{n-1} u(n-1)\leftrightarrow\frac{z^{-1}}{1-\frac{1}{4}z^{-1}}$$

So, $y(n)=\left(\frac{1}{4}\right)^{n-1}u(n-1)$

19. Ans: 4 (no range)

Sol: $\frac{1}{T_S}=8000$

So, T_S = 125μ sec

The separation between samples is 5μsec

As the sample is represented by a pulse of 1μsec duration. The separation between two successive pulses is 4 μsec.

20. Ans: (d)

Sol: $(1+t)\frac{dy}{dt}=4y$

$$\int\frac{1}{y}dy=\int\frac{4}{1+t}dt$$

$\log y = 4\log(1+t)+\log(c)$

$y=c(1+t)^4$

$y(0)=1 \Rightarrow 1=c(1+0)^4 \Rightarrow c=1$

$\Rightarrow y=(1+t)^4$

21. Ans: (c)

Sol: $H_1(z)=\frac{z^2+1.5z-1}{z^2}$ and

$H_2(z) = z^2+1.5z-1$

∴ The zeros of the functions will be identical but not the poles.

22. Ans: (d)

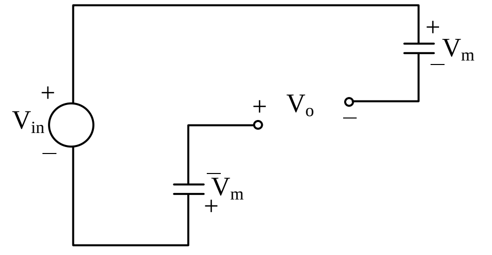
Sol: $$\frac{E}{R}=\frac{1}{1-\left[-\frac{4}{s+1}-\frac{4}{s+1}\right]}=\frac{s+1}{s+9}$$

23. Ans: (d)

Sol: During positive cycle D_3 is FB, D_4 is RB. Hence C_1 gets charged to V_m

During Negative cycle D_1 is FB, D_2 is RB. Hence C_2 gets charged to $-V_m$

After the capacitors are charged, the diodes will remain reverse biased



KVL

$-V_{in}+V_m-V_o-V_m=0$

$V_o=-V_{in}$

24. Ans: 1 (No range)

Sol: If rank of A is 2, then |A| = 0

$\Rightarrow x^3-1$

$(x-1)(x^2+x+1)=0$

$\Rightarrow x=1,\ \frac{-1\pm\sqrt{3}i}{2}$

$\therefore x=1$

25. Ans: (b)

Sol: $\overline{E} = \cos(\omega t + \beta z)\hat{a}_x + \sin(\omega t + \beta z)\hat{a}_y$

Phase difference = 90°

And amplitude of both components are equal

∴ Circularly polarized.

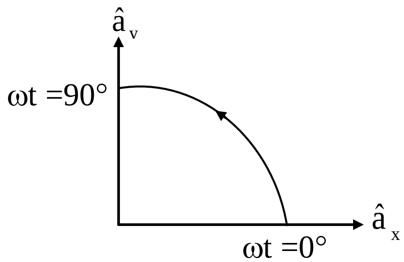
Let Z = 0

$\overline{E} = \cos(\omega t)\hat{a}_x + \sin(\omega t)\hat{a}_y$

$\omega t = 0 \Rightarrow \overline{E} = \hat{a}_x$

$\omega t = 90° \Rightarrow \overline{E} = \hat{a}_y$

∴ Anti-Clockwise direction



⇒ left circularly polarized.

26. Ans: (d)

Sol: Given curve 'C' is a closed curve.

So, we have to evaluate the integral by using Green's theorem.

By Green's theorem, we have

$$\oint_C (M\,dx + N\,dy) = \iint_R \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}\right) dx\ dy$$

Now, $\oint_C [(x-y)dx + (x+3y)\,dy]$

$$= \iint_R \left[\frac{\partial}{\partial x}[x+3y] - \frac{\partial}{\partial y}(x-y)\right] dx\ dy$$

$$= \iint_R [1-(-1)]\,dx\,dy$$

$$= 2\iint_R 1\,dx\,dy$$

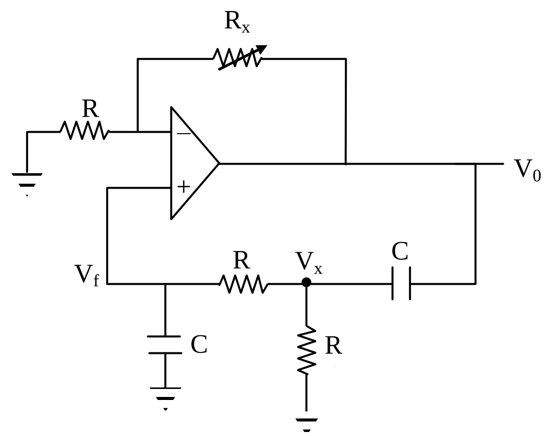
= 2(Area of the circle 'C')

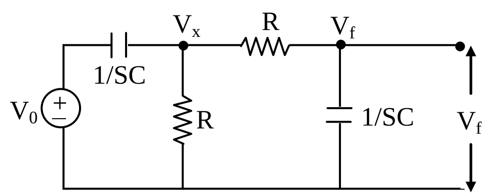
$= 2(\pi r^2)_{r=4}$

$= 32\pi$

27. Ans: (c)

Sol:



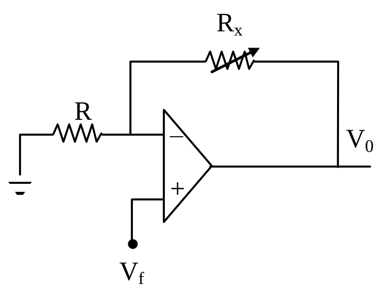


Feedback Network

$$\frac{V_0 - V_x}{\frac{1}{SC}} = \frac{V_x}{R} + \frac{V_x - V_f}{R} \quad \text{……. (1)}$$

and $\dfrac{V_x - V_f}{R} = \dfrac{V_f}{\frac{1}{SC}}$ …… (2)

∴ $V_x = (1+SRC)\,V_f$ --------(3)



$$\Rightarrow \beta = \frac{V_f}{V_0} = \frac{SCR}{S^2C^2R^2 + 3SCR + 1}$$

[$\because$ from equation (1), (2) & (3)]

$$\therefore \beta = \frac{1}{3 + j\left[\omega CR - \frac{1}{\omega CR}\right]}$$

$$\frac{V_0}{V_f} = 1 + \frac{R_x}{R}$$

Since for sustained oscillations $\beta A = 1$

$$\Rightarrow A = \frac{1}{\beta}$$

$$\therefore 1 + \frac{R_x}{R} = 3 + j\left[\omega CR - \frac{1}{\omega CR}\right]$$

Equating img., parts

$$\Rightarrow \omega CR - \frac{1}{\omega CR} = 0$$

$$\Rightarrow f = \frac{1}{2\pi RC} \text{Hz}$$

$$\& \ 1 + \frac{R_x}{R} = 3$$

$\therefore R_x = 2R$

28. Ans: 4.5 (No range)

Sol: Given f = 250MHz

Beam area Ω_A = product of half power widths

$$D = \frac{4\pi}{\Omega_A} = \frac{41259}{30^\circ \times 35^\circ} = 39.29$$

$$D = \frac{4\pi}{\lambda^2} A_e$$

(or)

$$A_e = \frac{\lambda^2}{4\pi} D$$

$$\lambda = \frac{3\times 10^8}{250\times 10^6}$$

$\lambda = 1.2\text{m}$

$$A_e = \frac{(1.2)^2}{(4\pi)} \times (39.29)$$

$\therefore A_e \simeq 4.5\text{m}^2$

29. Ans: 0.2

Sol: Given that $\frac{dy}{dx} = x^3 - 2y$ $\quad (\because \frac{dy}{dx} = f(x, y))$

with y(0) = 0.25 $\quad (\because y(x_0) = y_0)$

Let $x_0 = 0$, $y_0 = 0.25$ & h = 0.1

Then $x_1 = x_0 + h = 0.1$

The formula for Euler's forward method is

$y(x_1) \simeq y_1 = y_0 + h\, f(x_0, y_0)$

$\Rightarrow y(0.1) \simeq y_1 = 0.25 + (0.1)\left(x_0^3 - 2y_0\right)$

$\Rightarrow y(0.1) \simeq y_1 = 0.25 + (0.1)\,[0 - 2(0.25)]$

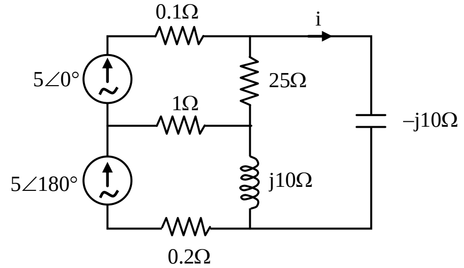
$\therefore y(0.1) \simeq y_1 = 0.25 - (0.1)(0.5)$

$= 0.25 - 0.05$

$= 0.2$

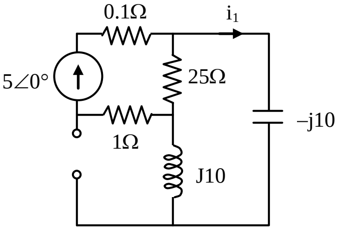
30. Ans: (b)

Sol:

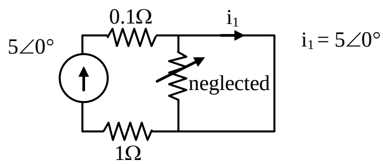


By super position principle $i = i_1 + i_{11}$

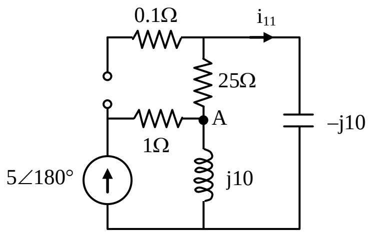
Current i_1: 5∠0° source acting alone



$-j10 + j10 = 0\ \Omega$ (short circuit)



Current i_{11}: $5\angle 180°$ source acting alone



By current division rule at node A

$$i_{11} = 5\angle 180° \times \frac{j10}{25 + j10 - j10}$$

$= 2j\angle 180°$

$= -2j$

$\therefore\ I = i_1 + i_{11} = 5 - 2j$ A

31. Ans: 31.6 (Range: 31 to 32)

Sol: $$P_e = Q\left[\sqrt{\frac{2A^2T_b}{N_0}}\right] = 7.8\times 10^{-4}$$

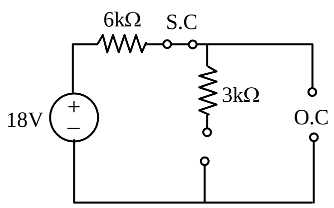
$$\sqrt{\frac{2A^2T_b}{N_0}} = \sqrt{10}$$

$$A^2 = \frac{5\times 2\times 10^{-9}}{10^{-5}} = 10^{-3}$$

$A = 31.6\times 10^{-3}$ V = 31.6mV

32. Ans: –60 (No Range)

Sol: At time $t = 0^-$ switch is in open condition

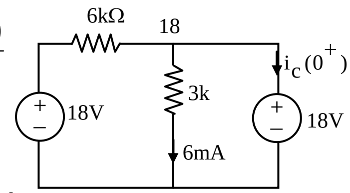


So, L is short circuit, C is open circuit

$i_L(0^-) = 0$

$V_C(0^+) = V_C(0^-) = 18V$

At $t = 0^+$ switch is closed



$$I_C(0^+) = C\frac{dv(0^+)}{dt}$$

$$\frac{dv(0^+)}{dt} = \frac{i_C(0^+)}{C}$$

$$i_C(0^+) = -6\times 10^{-3}\,A$$

$$\frac{dv(0^+)}{dt} = \frac{-6\times 10^{-3}}{100\times 10^{-6}}$$

$$\frac{dv(0^+)}{dt} = -60\,V/sec$$

33. Ans: 16 (Range: 15.9 to 16.2)

Sol: $G(s)\,H(s) = \dfrac{10}{(s+2)^4}$

$$\angle G(j\omega)\,H(j\omega) = \angle\frac{10}{(j\omega+2)^4}$$

$$\text{Gain margin(GM)} = 20\log\frac{1}{|G(j\omega)H(j\omega)|_{\omega=\omega_{PC}}}$$

$$\angle G(j\omega)H(j\omega)\big|_{\omega=\omega_{PC}} = -180^{o}$$

$$\angle\frac{10}{(j\omega+2)^4}\bigg|_{\omega=\omega_{pc}} = -180^{o}$$

$$-4\tan^{-1}\frac{\omega_{pc}}{2} = -180^{o}$$

$\Rightarrow \omega_{PC} = 2$

$$|G(j\omega)H(j\omega)|_{\omega=\omega_{PC}} = \left|\frac{10}{(j(2)+2)^4}\right|$$

$$= \frac{10}{\left(\sqrt{2^2+2^2}\right)^4} = \frac{10}{64}$$

$$\text{Gain margin} = 20\log\frac{64}{10}$$

$= 20[\log 64 - \log 10]$

$= 20\,[6\,(0.3) - 1]$

$= 16$ (Range: 15.9 to 16.2)

34. Ans: 1.69 (Range: 1.45 to 1.85)

Sol: The value of K can be determined from the following equation:

$$K = \frac{I_{D(on)}}{\left(V_{GS(on)} - V_{GS(th)}\right)^2}$$

$$= \frac{10mA}{(10V - 1.5V)^2} = 1.38\times10^{-1} mA/V^2$$

$[\because V_{GS\,(on)} = 10V]$

From the circuit, the source voltage is seen to be 0V.

Therefore, $V_{GS} = V_G - V_S = V_G - 0 = V_G$.

The value of V_G (= V_{GS}) is given by:

$$V_G (\text{or } V_{GS}) = \frac{V_{DD}}{R_1 + R_2}\times R_2$$

$$= \frac{10V}{(1+1)M\Omega}\times 1M\Omega = 5V$$

$I_D = K\,(V_{GS} - V_{GS\,(th)})^2$

$= (1.38\times10^{-1} mA/V^2)\,(5V - 1.5V)^2$

$= 1.69mA$

35. Ans: 0.0045 (Range: 0.004 to 0.005)

Sol: Let X = number of accidents between 5 P.M and 6 P.M.

For Poisson distribution,

$\lambda = np = (1000)\,(0.0001) = 0.1$

$P(X = x) = \dfrac{e^{-\lambda}.\lambda^x}{\angle x}$ (x = 0, 1, 2,……..)

Required Probability = $P(X \geq 2)$

$= 1 - P(X < 2)$

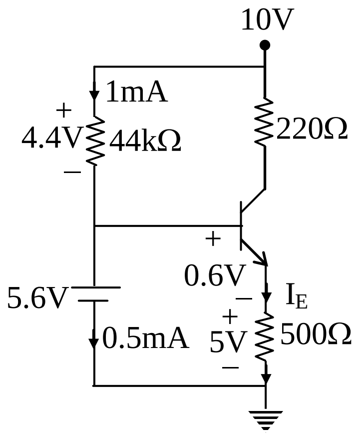
$= 1 - \{P(X = 0) + P(X = 1)\}$

$= 1 - e^{-0.1}\,(1 + 0.1)$

$= 0.0045$

36. Ans: 0.95 (No range)

Sol: Zener diode is in breakdown, replace it with a voltage source of value V_Z = 5.6V & V_{BE} = 0.6V



Applying KCL at Base, we get

$-1mA + 0.5mA + I_B = 0$

$I_B = 0.5mA$

$I_E = \dfrac{5}{500\Omega} = 10mA$

$I_E = (\beta+1)\,I_B$

$\beta+1 = \dfrac{I_E}{I_B}$

$\beta+1 = \dfrac{10}{0.5}$

$\beta + 1 = 20$

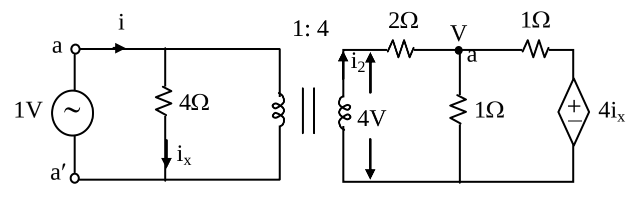
$\beta = 19$

$\alpha = \dfrac{\beta}{1+\beta} = \dfrac{19}{20} = 0.95$

37. Ans: 171 (Range: 165 to 175)

Sol: Now 1V is applied at primary side a-a′

$R = \dfrac{1}{i}$



By transformation ratio

$K = \dfrac{4}{1} = 4$

$\dfrac{V_2}{V_1} = k = 4$

$V_2 = 4V$

$i_x = \frac{1}{4}A$

Apply KCL at node-a,

$$\frac{V-4}{2}+\frac{V}{1}+\frac{V-4i_x}{1}=0$$

$$V - 4 + 2V + 2V - 8i_x = 0$$

$$5V = 4 + 8i_x = 4 + 8\frac{1}{4} = 6$$

$$V = \frac{6}{5}V$$

i_2 is current flows through secondary winding then

$$i_2 = \frac{4-\frac{6}{5}}{2}=\frac{14}{10}=1.4A$$

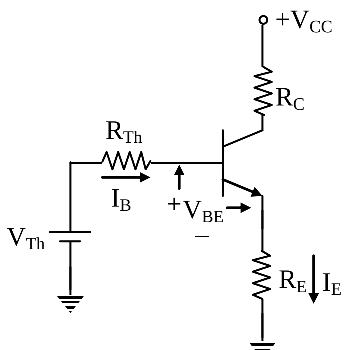
This i_2 transferred to primary then $i_2' = 1.4\times 4$

$$\therefore\ i = i_x + i_2' = \frac{1}{4}+1.4\times 4 = 5.85\ A$$

$$\therefore\ R = \frac{1}{i} = \frac{1}{5.85} = 171\ m\Omega$$

38. 4.92 (Range: 4.8 to 5.1)

Sol:



fig(a): Thevenin equivalent of the given circuit

Step (1):

KVL for the input loop of circuit shown in fig (a)

$V_{Th} - I_B R_{Th} - V_{BE} - I_E R_E = 0$ ------- (1)

$$I_E = \frac{V_{Th}-V_{BE}}{R_E+\frac{R_{Th}}{1+\beta}} \text{ ---- (2) } \left[\because I_B = \frac{I_E}{1+\beta}\right]$$

$$V_{Th} = \frac{V_{CC}R_2}{R_1+R_2}$$

$R_{Th} = R_1 // R_2$

Step (2):

$$\text{But } I_E R_E = \frac{V_{CC}}{3} = \left[\frac{V_{Th}-V_{BE}}{R_E+\frac{R_{Th}}{1+\beta}}\right] R_E \text{ ----- (3)}$$

($\because$ Given that voltage drop across $R_E = \frac{V_{CC}}{3}$)

$$\left\{\frac{(V_{Th}-V_{BE})}{R_E\left[1+\left(\frac{R_{Th}}{R_E}\right)\left(\frac{1}{1+\beta}\right)\right]}\right\} R_E = \frac{V_{CC}}{3} \text{ ----- (4)}$$

$$V_{Th} = \frac{V_{CC}}{3}\left[1+\left(5.73\times\frac{1}{101}\right)\right]+V_{BE} \text{ ----- (5)}$$

$V_{Th} = 4.92693V$ -------- (6)

39. Ans: (b)

Sol: Given $v = y + e^{-x}\cos y$

$\Rightarrow v_x = -e^{-x}\cos(y)$ and $v_y = 1 - e^{-x}\sin(y)$

Consider $du = (u_x)\,dx + (u_y)\,dy$

$= (v_y)\,dx + (-v_x)\,dy$

$\Rightarrow du = (1 - e^{-x}\sin y)\,dx + (e^{-x}\cos y)\,dy$

$\Rightarrow \int du = \int (1 - e^{-x}\sin y)\,dx + \int 0\,dy + k$

$\Rightarrow u = x + e^{-x}\sin y + k$

Now the required analytic function f(z) is given by $f(z) = u + iv$

$\Rightarrow f(z) = (x + e^{-x}\sin y + k)$

$+ i\,(y + e^{-x}\cos y)$

$\therefore\ f(z) = z + ie^{-z} + k$

40. Ans: (b)

Sol: For break point,

$$\frac{dk}{ds}=0$$

$$\frac{d}{ds}\left(\frac{1}{G(s)H(s)}\right)=0$$

$$\frac{d}{ds}(s(s+6)(s^2+4s+13)) = 0$$

$$(s^2+6s)[2s+4] + (s^2+4s+13)[2s+6] = 0$$

$$2s^3+16s^2+24s+2s^3+6s^2+8s^2+24s+26s+78 = 0$$

$$4s^3 + 30s^2 + 74s + 78 = 0$$

$$f(s) = 2s^3 + 15s^2 + 37s + 39 = 0 \text{ -------(1)}$$

$$f(-5) = -21$$

$$f(-4) = 3$$

$$f(-3) = 9$$

As there is a sign change in between –5, –4, one root is on real axis, which is in between –5, –4. Three real axis break points is not possible.

41. Ans: (b)

Sol: $$f(t) = \left(-\frac{t}{T}+1\right)[u(t)-u(t-T)]$$

$$f(t) = \left(-\frac{t}{T}\right)[u(t)-u(t-T)]+[u(t)-u(t-T)]$$

$$[u(t)-u(t-T)]\leftrightarrow\frac{1}{s}-\frac{e^{-sT}}{s}$$

From differentiation in s-domain property

$$\left(-\frac{t}{T}\right)[u(t)-u(t-T)]\leftrightarrow\frac{1}{T}\frac{d}{ds}\left(\frac{1}{s}-\frac{e^{-sT}}{s}\right)=\frac{1}{T}\left[\frac{-1}{s^2}-\frac{\left(se^{-sT}(-T)-e^{-sT}\right)}{s^2}\right]$$

$$\left(-\frac{t}{T}\right)[u(t)-u(t-T)]\leftrightarrow\frac{1}{T}\left[\frac{-1}{s^2}+T\frac{e^{-sT}}{s}+\frac{e^{-sT}}{s^2}\right]=\frac{e^{-sT}}{s}+\frac{e^{-sT}}{Ts^2}-\frac{1}{s^2T}$$

$$F(s)=\frac{1}{s}-\frac{e^{-sT}}{s}+\frac{e^{-sT}}{s}+\frac{e^{-sT}}{Ts^2}-\frac{1}{s^2T}=\frac{1}{s}+\frac{e^{-sT}}{Ts^2}-\frac{1}{s^2T}=\frac{1}{s^2T}\left[sT-1+e^{-sT}\right]$$

42. Ans: 3 (No range)

Sol: $J_0=\overline{Q}_1$; $K_0 = 1$; $J_1 = Q_0$; $K_1 = 1$

J_0	K_0	J_1	K_1	Q_0	Q_1
				0	0
1	1	0	1	1	0
1	1	1	1	0	1
0	1	0	1	0	0
1	1	0	1	1	0

→ It is a mod-3 counter.

43. Ans: 0.707 (Range: 0.70 to 0.80)

Sol: Propagation constant

$$\gamma=\sqrt{(R+j\omega L)(G+j\omega C)}$$

$$=\sqrt{(30+j2\pi\times10^3\times100\times10^{-3})(j2\pi\times10^3\times20\times10^{-6})}$$

$$=\sqrt{(30+j200\pi)(j0.04\pi)}$$

$$=\sqrt{(-78.95+j3.76)}$$

$$\gamma = 8.889\angle 88.63°$$

$$\gamma = \alpha + j\beta = [0.212 + j8.887]\text{km}^{-1}$$

$$\beta = 8.887\text{rad/km}$$

Phase velocity, $\nu_p=\frac{\omega}{\beta}$

$$= \frac{2\pi\times10^3}{\frac{(8.887)}{10^3}}$$

$\nu_p = 0.707 \times 10^6$

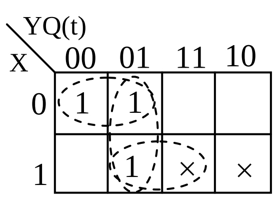
$\therefore\ \nu_p = 0.707$ Mm/sec

44. Ans: (c)

Sol: By giving different sets of input values and Q(t) (present state) we have to determine next state Q(t+1)

X	Y	Q(t)	S	R	Q(t+1)
0	0	0	1	0	1
0	0	1	1	0	1
0	1	0	0	1	0
0	1	1	0	1	0
1	0	0	0	0	0
1	0	1	0	0	1
1	1	0	1	1	×
1	1	1	1	1	×

K-map for Q (t + 1)



$$\therefore\ Q(t+1) = \overline{X}\,\overline{Y} + \overline{Y}Q(t) \qquad \text{or}$$

$$Q(t+1) = \overline{X}\,\overline{Y} + XQ(t)$$

45. Ans: 0.5

Sol: Given y(n) be a 4 point circular convolution of x(n) & h(n)

y(n) = x(n) circular convolution h(n)

Apply DFT

Y(k) = X(k) H(k)

Y(k) = {1, –2,1, –2}. {1, j, 1, –j}

= {1, – 2j, 1, 2j}

$$\text{IDFT}\ \ y(n) = \frac{1}{N}\sum_{k=0}^{N-1} Y(k)e^{j\frac{2\pi}{N}nk}$$

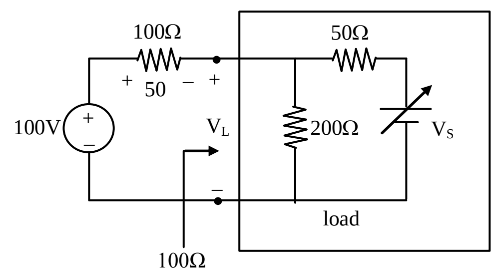
$$y(0) = \frac{1}{N}\sum_{k=0}^{N-1} Y(k)$$

N = 4

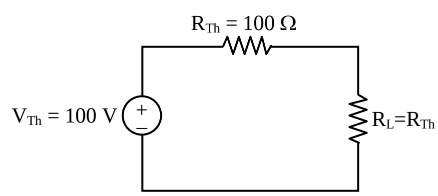
$$y(0) = \frac{1}{4}\sum_{k=0}^{3} Y(k) = \frac{1}{4}[1-2j+1+2j] = \frac{2}{4} = \frac{1}{2}$$

46. Ans: 37.5 (Range: 37 to 38)

Sol: Applying thevenin's theorem in the source side, the circuit can be redrawn as



We know that for maximum power transform, the load resistance is equal to Thevenin's resistance.



Voltage drop across load, $V_L = \dfrac{V_{Th}\times R_L}{R_{Th}+R_L}$

$\Rightarrow V_L = \dfrac{V_{Th}\times R_L}{2R_{Th}}$

$V_L = \dfrac{V_{Th}}{2}$

Consider above figure, for maximum power transferred to load

$V_L = \frac{V_{TH}}{2} = \frac{100}{2}$ = 50 Volts

Applying nodal analysis, we get

$\Rightarrow \frac{50}{100} = \frac{50}{200} + \frac{50 - V_s}{50}$

$\Rightarrow \frac{50 - V_s}{50} = \frac{1}{4}$

$\Rightarrow 50 - V_s = 12.5$

$\Rightarrow V_s = 37.5$ V

47. Ans: (c)

Sol: $A_c \cos 2\pi f_c t + \frac{A_c\mu}{2}\cos 2\pi(f_c + f_m)t + \frac{A_c\mu}{2}\cos 2\pi(f_c - f_m)t$

USB is attenuated by a factor of '2'

$= A_c \cos 2\pi f_c t + \frac{A_c\mu}{4}\cos 2\pi(f_c + f_m)t + \frac{A_c\mu}{2}\cos 2\pi(f_c - f_m)t$

$= \cos 2\pi f_c t + \frac{1}{8}\cos 2\pi(f_c + f_m)t + \frac{1}{4}\cos 2\pi(f_c - f_m)t$

The inphase component is

$\left[1 + \frac{1}{8}\cos 2\pi f_m t + \frac{1}{4}\cos 2\pi f_m t\right].\cos 2\pi f_c t = \left[1 + \frac{3}{8}\cos 2\pi f_m t\right]$

48. Ans: (b)

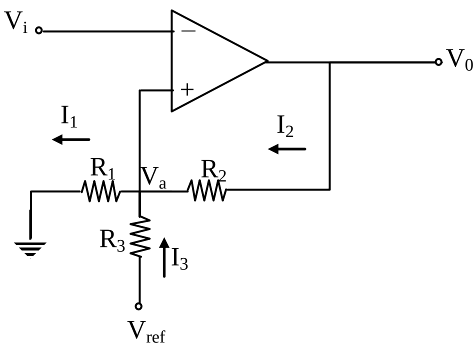
Sol:
- (SP) = 8086H
- (DE) = 8085H
- (HL) exchanged with (DE)
  After execution
  (HL) = 8085H, (DE) = ××××H
- (HL) = 8085H = 1000 0000 1000 0101
  (SP) = 8086H = 1000 0000 1000 0110
  (HL) = 010BH = 0000 0001 0000 1011
- (HL) = 010BH copied into (SP)
  $\Rightarrow$ (SP) = 010BH
- 8085 microprocessor calls delay subroutine and after execution of subroutine, microprocessor returns to main program.
  SP contents decremented by 2 for CALL operation
  SP contents incremented by 2 for RETURN operation
  i.e., (SP) = 010BH – 2 + 2
  = 010BH
- 8085 microprocessor pushes DE pair contents to stack. SP contents will be decremented by 2 for PUSH operation.
  (SP) = 010BH – 2 = 0109H
- 8085 microprocessor executes RST 7 software interrupt where it calls respective ISR and returns to main execution.
  (SP) = 0109H – 2 + 2 = 0109H
- 8085 microprocessor contents of top 2 stack locations back into PSW. SP contents will be incremented by 2 for POP operation.
  (SP) = 0109H + 2 = 010BH
- (SP) = 010BH

49. Ans: 2.19 (2.18 to 2.20)

Sol: Apply KCL at V_a

$I_1 = I_2 + I_3$

$$\frac{V_a}{R_1} = \frac{V_{ref} - V_a}{R_3} + \frac{V_0 - V_a}{R_2}$$



$$V_a\left[\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right] = \frac{V_{ref}}{R_3} + \frac{V_0}{R_2}$$

$V_a = V_{UTP}$ when $V_0 = +V_{sat}$

$V_a = V_{LTP}$ when $V_0 = -V_{sat}$

$$V_a = \frac{\frac{V_{ref}}{R_3} + \frac{V_{sat}}{R_2}}{\left[R_1^{-1} + R_2^{-1} + R_3^{-1}\right]}$$

$$V_{UTP} = \frac{\frac{-10}{10} + \frac{12}{50}}{\left[\frac{1}{10} + \frac{1}{10} + \frac{1}{50}\right]} = -3.4545 \text{ V}$$

$V_{LTP} = -5.6363$ V

$V_H = V_{UTP} - V_{LTP}$

$V_H \approx 2.19$

50. Ans: (d)

Sol: $X(\omega) = \dfrac{1}{(2 + j\omega)^2}$

$$H(\omega) = \frac{1}{4 + j\omega}$$

$$Y(\omega) = X(\omega).H(\omega) = \frac{1}{(4 + j\omega)(2 + j\omega)^2}$$

$$= \frac{1/4}{4 + j\omega} - \frac{1/4}{2 + j\omega} + \frac{1/2}{(2 + j\omega)^2}$$

$$y(t) = \frac{1}{4}e^{-4t}u(t) - \frac{1}{4}e^{-2t}u(t) + \frac{1}{2}te^{-2t}u(t)$$

$$y(3) = \frac{1}{4}e^{-12} - \frac{1}{4}e^{-6} + \frac{3}{2}e^{-6} = \frac{1}{4}e^{-12} + \frac{5}{4}e^{-6}$$

51. Ans: (a)

Sol: Given that $\beta = 1$

loss tangent $\dfrac{\sigma}{\omega \in} = \tan[2\,\text{phase}\,\eta]$

$= \tan(60)$

$= \sqrt{3}$

$$\frac{\alpha}{\beta} = \frac{\sqrt{\frac{\mu \in}{2}}\left(\sqrt{1 + \left(\frac{\sigma}{\omega \in}\right)^2} - 1\right)^{1/2}}{\sqrt{\frac{\mu \in}{2}}\left(\sqrt{1 + \left(\frac{\sigma}{\omega \in}\right)^2} + 1\right)^{1/2}}$$

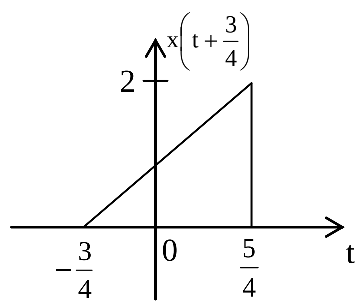
By solving this

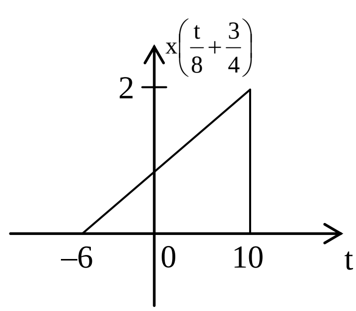
$$\frac{\alpha}{\beta} = \frac{[2-1]^{1/2}}{[2+1]^{1/2}} = \frac{1}{\sqrt{3}}$$

$$\alpha = \frac{1}{\sqrt{3}} \quad [\because \beta = 1]$$

52. Ans: (d)

Sol:





53. Ans: (a)

Sol: Given $(2xy - 9x^2)dx + (2y + x^2+1)dy = 0$

Here, $M = 2xy - 9x^2$ and $N = 2y + x^2 + 1$

Now, $\frac{\partial M}{\partial y} = 2x = \frac{\partial N}{\partial x}$

$\therefore$ The given D.E is exact

Now the general solution of the given D.E is

$\int(2xy - 9x^2)dx + \int(2y + 0 + 1)dy = C$

$\Rightarrow x^2y - 9\frac{x^3}{3} + y^2 + y = C$ .... (1)

but $y = -3$ at $x = 0$

Now (1) becomes

$0 - 0 + 9 - 3 = C$

$\Rightarrow C = 6$

$\therefore$ The solution of a given D.E is

$x^2y - 3x^3 + y^2 + y = 6$

54. Ans: 31 (No range)

Sol: P = Signal power

$= E[x^2(t)] = 2\int_0^1 x^2(-x+1)dx = \frac{1}{6}W$

Figure of merit = $\frac{\frac{1}{6}}{1+\frac{1}{6}} = \frac{1}{7}$

$\left(\frac{S}{N}\right)_o = 40\,dB$

$\frac{S_i}{n_i} = 7\times10^4$

$S_i = 7\times10^4\times2\times10^{-12}\times4\times10^3$

$= \frac{A_C^2}{2}[1+K_a^2P]$

$K_a = \mu/A_m = 1$

$A_C = 31$ mV

55. Ans:0 (No range)

Sol: $\delta(t^2 - a^2) = \frac{1}{2|a|}[\delta(t+a)+\delta(t-a)]$

$I = \int_{-1}^{1}\frac{1}{4}[\delta(t-2)+\delta(t+2)]dt$

$I = \frac{1}{4}\int_{-1}^{1}\delta(t-2)dt + \frac{1}{4}\int_{-1}^{1}\delta(t+2)dt$

From sifting property

$\int_{t_1}^{t_2} x(t)\delta(t-t_0)dt = x(t_0) \quad t_1 \le t_0 \le t_2$

$= 0 \quad$ otherwise

$I = 0 + 0 = 0$

56. Ans: (d)

Sol: (PART AND THE WHOLE) A fragment is a piece of broken bone; a shard is a piece of broken pottery. (d)

57. Ans: (a)

58. Ans: (d)

Sol: irretrievably means impossible to recover or get back, so irrevocably is the correct synonym, which means not capable of being changed : impossible to revoke.

59. Ans: (b)

Sol: Indiscriminate (adj.) means not discriminating or choosing randomly; haphazard; without distinction.

60. Ans: (a)

Sol: $a_0 = 1$; $a_n = 2a_{n-1}$ if n is odd

$a_n = a_{n-1}$ if n is even

$a_{100} = a_{100-1} = a_{99} = 2.a_{99-1}$

$= 2.a_{99} = 2.a_{98-1} = 2a_{97}$

$= 2.2a_{97-1} = 2^2.a_{96}$ ……… $2_{50}.a_0 = 2^{50}$

61. Ans: (c)

Sol: A = 1; B = 1

(a) B = B + 1 = 2

(b) & (c) A = A × B = 1 × 2 = 2

Step 2: B = 2 + 1 = 3; A = A × B = 2 × 3 = 6

Step 3: B = 3 + 1 = 4; A = A×B = 6 × 4 = 24

Step 4: B = 4 + 1 = 5; A = 24 × 5 = 120

Step 5: B = 5 + 1 = 6; A = 120 × 6 = 720

62. Ans: (a)

Sol: Ratio of efficiency (P & Q) = 2 : 1

Ratio of efficiency (P + Q, R) = 3 : 1

If R does 1 unit work, then P& Q together do 3 units.

Out of 3 units, P does 2 units and Q does 1 unit.

∴ Ratio of efficiency (P, Q & R) = 2 : 1 : 1

Hence, earnings should be divided in the ratio is 2 : 1 : 1

63. Ans: (c)

Sol: In 1972, A was as old as the number formed by the last two digits of his year of birth.

So, A was born in 1936 (as in 1972, he is 36 yrs older also, last two digits of 1936 are 36).

Hence, B was born in 1936 + 15 = 1951

so, he is 21 yrs old in 1972

64. Ans: (b)

Sol: Difference (in thousands) between the numbers of customers in the 2 complexes in:

January: 22 – 20 = 2

February: 25 – 24 = 1

March: 20 – 15 = 5

April: 28 – 25 = 3

May: 20 – 14 = 6 [Max]

June: 20 – 15 = 5

65. Ans: (b)

Sol: The issue is more about punishing criminals, and so punishment is more important than crime prevention (correct answer B).