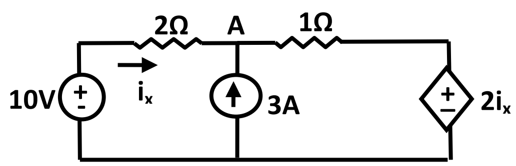
Answer Keys: ECE-TS-1

1	C	2	A	3	B	4	C	5	C	6	B	7	A	8	B	9	B	10	B
11	D	12	B	13	B	14	B	15	A	16	B	17	C	18	D	19	A	20	C
21	B	22	D	23	B	24	C	25	A	26	A	27	B	28	B	29	C	30	C
31	C	32	C	33	A	34	A	35	D	36	C	37	D	38	B	39	D	40	C
41	D	42	B	43	A	44	C	45	B	46	B	47	A	48	B	49	C	50	D
51	C	52	C	53	C	54	B	55	B	56	D	57	A	58	C	59	A	60	B
61	C	62	B	63	B	64	D	65	C										

Explanation:

1. **[Ans .C],** Applying KCL at node A; and node voltage



$i_x + 3 = \frac{v-2i_x}{1}$ ---------- (1)

$i_x = \frac{10-v}{2}$ --------- (2)

$\Rightarrow V = -2i_x + 10$

Replacing in 1,

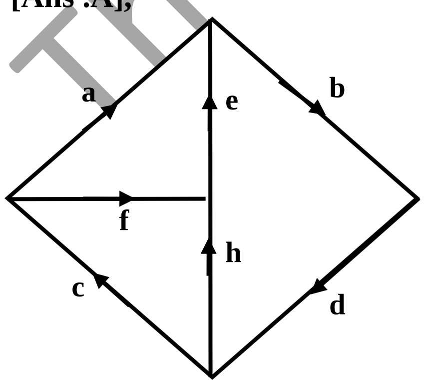
$i_x + 3 = -2i_x + 10 - 2i_x$

$\Longrightarrow 5i_x = 7$

$\Longrightarrow i_x = 7/5 = 1.4A$,

Option (C) is correct

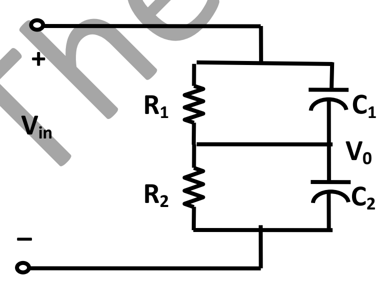
2. **[Ans .A],**



Option (A): e f g h, since current sources are O.C in a graph.

3. **[Ans .B],** $\frac{d(V_L - V_C)}{dI_L} = \frac{dV_R}{dI_L}$ ($\because$ V_R (t) = V_R (t) – V_C (t))
   $= \frac{-dV_R}{dI_R}$ ($\because$ I_L = - I_R)
   At any t,
   $\therefore \frac{d(V_L - V_C)}{dI_L} = -10.$
   Hence (B)
4. **[Ans .C],** M = $xy^2 + \lambda x^2 y$
   N = $(x + y)x^2$
   for exact differential equation
   $\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$
   $3x^2 + 2xy = 2xy + \lambda x^2$
   $\Rightarrow \lambda = 3$
   Option (C) is correct
5. **[Ans .C],** $\underset{z=1}{\text{Res}}\, f(z) = \lim_{z\to 1} \frac{d}{dz}\ [\ (z-1)^2 f(z)\ ]\ = \lim_{z\to 1} \frac{d}{dz} \left(\frac{50z}{(z+4)}\right) = 8$
   Ans (C)
6. **[Ans .B],** which leads to very low f'(x_0)
7. **[Ans .A],**
   By simple expansion of $e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!}$, we get the result.
8. **[Ans .B],** P = $\frac{E^2}{R}$
   $\log P = 2 \log E - \log R$
   $\frac{\delta P}{P} = 2\frac{\delta E}{E} - \frac{\delta R}{R}$
   $\frac{\delta P}{P} \times 100 = 2\frac{\delta E}{E} \times 100 - \frac{\delta R}{R} \times 100$
   $\frac{\delta P}{P} \times 100 = 2(3) — (-2) = 8$
   Ans. (B) is correct
9. **[Ans .B]**,
   Correct answer is $\frac{V_0}{V_i}$ = 1/SCR

10.



Solution:

$\frac{V_0}{V_{in}} = \frac{R_2}{R_1+R_2} - \frac{1+SC_1R_1}{1+S.\frac{R_1R_2}{R_1+R_2}(C_1+C_2)}$

For $\frac{V_0}{V_{in}}$ = constant,

So, here,

$R_1C_1 = \frac{R_1R_2}{R_1+R_2}(C_1 + C_2)$

R = 10k

or $R_1C_1 = R_2C_2$

Option (B) is correct

11. **[Ans .D]**
$\Delta f = k_P A_m = 5k$ B.W. $=2(fm + \Delta f)$, so when A_m is increased by factor of 3 New $\Delta f = 15k$
$\therefore B.W. = 2(1+15) = 32k$
12. **[Ans .B]**
13. **[Ans .B]**

At T = 300K, intrinsic concentration Si= Ni = 10^{10}
→ Boron is acceptor impurity
∴ Si is p –type
also Hole concentration = p≈ $N_A = 10^{17}/cm^3$ and we know that the product of majority and minority carrier is constant.
$p^n = N{:}2$
$\therefore 10^{17} \times n = 10^{20} \Rightarrow n = 10^3/cm^3$(option- B)

14. **[Ans .B]**
15. **[Ans .A]**
16. **[Ans .B]**
17. **[Ans .C]**
18. **[Ans .D],** For (D), $y(e^{J\omega}) = e^{J2\omega} . x(e^{J\omega})$
$|y(e^{J\omega})| = |x(e^{J\omega})|, \forall\omega$
Hence (D)
19. **[Ans .A]**
$y[n] = \delta(n) + 2x[n-3]$ is non linear since super position principle fails and time variant as $y(n-n_0) \neq T\{x(n-n_0)\}$
20. **[Ans .C]**
For each amplifier transfer function is $\frac{A}{1+\frac{S}{\omega_0}}$
Here, $\omega_0 = 2\pi f_0$; f_0 is the 3 dB frequency.
For N identical cascaded stages transfer function is $\frac{A^N}{\left(1+\frac{S}{\omega_0}\right)^N}$; dc gain = A^N

Magnitude of gain = $\frac{A^N}{\left\{1+(\frac{\omega}{\omega_0})^2\right\}^{\frac{N}{2}}}$
At 3 dB for this cascaded stage,
$\frac{A^N}{\left\{1+(\frac{\omega}{\omega_0})^2\right\}^{\frac{N}{2}}} = \frac{A^N}{\sqrt{2}}$; which gives
$\omega = \omega_0\sqrt{2^{1/N}-1}$ as 3 dB frequency
For 2 stage, $f_{3dB} = f_0\sqrt{\sqrt{2}-1} = 0.6436 f_0$
21. **[Ans .B]**
22. **[Ans .D]**
23. **[Ans .B]**
24. **[Ans .C],** In bode – magnitude plot,
Steady state decay = -20 (P – z) dB/decade
Given z = 3, ∴ p – z = 3 ⇒ p = 6

Hence (C)

25. **[Ans .A]**

s^5	1	-1	-4
s^4	-1	-7	-4
s^3	-8	-8	
s^2	-6	-4	
s^1	-8/3		
s^0	-4		

number of sign changes = number of roots with positive read port = 1

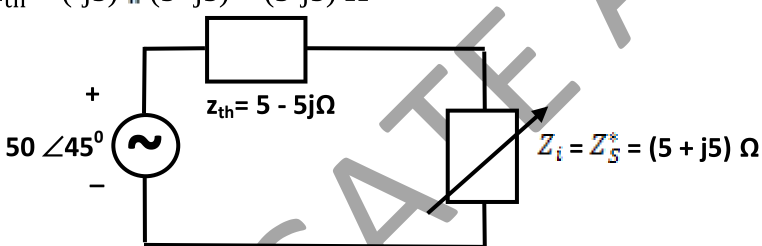
∴ number of roots on left half of s – plane = 5-1 = 4

Hence (A)

26. **[Ans .A]**

$V_{th} = (\frac{50\angle 0^0}{-J5+J5+5})$ (j5 + 5Ω) = 10 $\angle 0^0$. $5\sqrt{2}\angle 45^0$ = 50 $\sqrt{2}\angle 45$.

Z_{th} = (-j5) ‖ (5+j5) = (5-j5) Ω



$I = \frac{50\sqrt{2}\angle 45^0}{5-j5+5+j5} = 5\sqrt{2}\angle 45^0$

$P_{max} = |5|^2$ (5) = 125w.

Ans (A)

27. **[Ans .B],** $A = \begin{bmatrix} -1 & 2 & 3 \\ 0 & 4 & -1 \\ 0 & 0 & 1 \end{bmatrix}$

Eigen value of A are $\lambda_1 = -1$, λ_2 = +1 , $\lambda_3 = 4$,

Eigen value of matrix B = $\lambda^3 + \lambda^2 + A + I$, are

$[\lambda_1]_B = \lambda_1^3 + \lambda_1^2 + \lambda_1 + 1 = 0$

$[\lambda_2]_B = \lambda_2^3 + \lambda_2^2 + \lambda_2 + 1 = 4$

$[\lambda_3]_B = \lambda_3^3 + \lambda_3^2 + \lambda_3 + 1 = 85$

Trace of B = $[\lambda_1]_B + [\lambda_2]_B + [\lambda_3]_B = 89$

Option (B) is correct

28. **[Ans .B],** $(D^2 - 2D + 1)y = \frac{e^x}{x}$

C.F = $(C_1 + C_2x)\, e^x$

P.I = $\frac{1}{(D-1)^2}\frac{e^x}{x} = e^x . \frac{1}{(D+1-1)^2} . \frac{1}{x}$

$= e^x \frac{1}{D} \log x = e^x \int \log x \, dx$

$= e^x (x \log x - x)$

complete solution = $(C_1 + C_2x)\, e^x + e^x\, (x \log x - x)$

$= (C_1 + C_2x + x \log x - x)\, e^x$

Option (B) is correct

29. **[Ans .C],** Probability of drawing a green balls from box y if the transferred ball is green ,

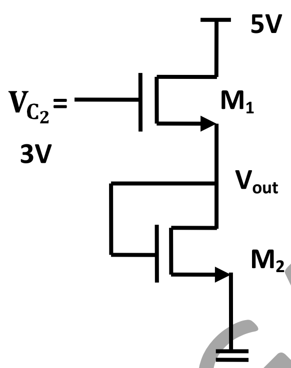
$P_1 = \frac{4}{6} x \frac{8}{13} = \frac{16}{39}$

probability of drawing of green ball from box y if the transferred ball is red , $P_1 = \frac{2}{6}\, x \frac{7}{13} = \frac{7}{39}$

Required probability = $P_1 + P_2 = \frac{22}{39}$

Option (C) is correct

30.



M_2 is diode connected so is in saturation

For M_1; V_D = 5V & V_G = 3V

V_{Th} = 1V (given) → Threshold voltage

So, $V_D > V_G - V_{Th}$; so M_1 is also in saturation

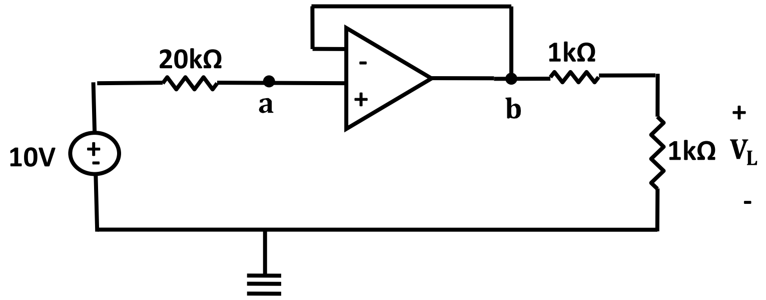
Now applying KCL at V_{out} ;

$$I_{M_1} = \mu_w C_{ox} \left(\frac{W}{L}\right) (V_G - V_{out} - V_{Th})^2 = I_{M_2} = \mu_w C_{ox} \left(\frac{W}{L}\right) (V_{out} - V_{Th})^2$$

$I_{M_1} = I_{M_2}$ gives, $V_{out} = \frac{V_G}{2} = 1.5V$

Option (C)

31. **[Ans .C],** Applying Thevenin's equivalent to left side of (A) point



v_a = 10V; v_b = 10V (buffer)

$v_L = v_b \cdot \frac{1k\Omega}{1k\Omega+1k\Omega}$ = 5V

Option (C)

32. **[Ans .C]**

Solution: For given system,

$\emptyset(S) = (SI - A)^{+} = \frac{1}{(S^2+2)}\begin{bmatrix} S & 1 \\ -2 & S \end{bmatrix}$

$\emptyset(t) = L^{-1}(\emptyset(S)) = \begin{bmatrix} \cos\sqrt{2}t & 1/\sqrt{2}\sin 2t \\ -\sqrt{2}\sin\sqrt{2}t & \cos\sqrt{2}t \end{bmatrix}$

$|\emptyset(t)| = 1 = \lambda_1 . \lambda_2$

Given $\lambda_1 = \lambda$, $\therefore \lambda_2 = 1/\lambda$

Hence (C)

33. **[Ans .A]**

$R_{XY}(t_1, t_0) = 1.5\delta(t_1 - t_0 + \tau) + 1.5\delta(t_0 - t_1 + \tau)$

34. **[Ans .A]**
35. **[Ans .D]**
36. **[Ans .C]**

$V_{bi} = \frac{KT}{9} \text{Ln}\left(\frac{N_A N_D}{N_i^2}\right) = 0.026V \text{ Ln}\left(\frac{5x10^{16} \times 10^{16}}{10^{20}}\right)$

= 0.76 V

$W_d = \left[2\frac{\epsilon_{si}}{q}V_{bi}\left(\frac{1}{N_A} + \frac{1}{N_D}\right)\right]^{\frac{1}{2}}$

$= \left[2 \times \frac{10^{-12}}{1.6\times10^{-19}} \times 0.76 \times \left(\frac{1}{5\times10^{16}} + \frac{1}{10^{16}}\right)\right]^{\frac{1}{2}}$

= 0.346 μ m

$\therefore V_{bi}$ = 0.76 V, W_d = 0.346μm

37. **[Ans .D]**
38. **[Ans .B]**
39. **[Ans .D]**
40. **[Ans .C]**

The energy of y (t) = 3x (t).e^{-j3t} is,

$E_x = \frac{1}{2\pi}\int_{-\infty}^{\infty}|X(\omega)|^2 d\omega$
$E_y = \frac{1}{2\pi}\int_{-\infty}^{\infty}|Y(\omega)|^2 d\omega$
$= \frac{1}{2\pi}\int_{-\infty}^{\infty}9|X(\omega)|^2 d\omega$
$=\frac{9}{2\pi}[2(\omega_0-\omega_1)\times 16 + 2\times(\omega_1)\times 9]$
$=\frac{9}{2\pi}[32\omega_0 - 32\omega_1 + 18\omega_1]$
$= \frac{9[32\omega_0-14\omega_1]}{2\pi}$
$= \frac{9(16\omega_0-7\omega_1)}{\pi}$

41. **[Ans .D]**

For $2^n\mu(n)$, Z.T. is $|z| > 2$

For $-\left(\frac{1}{3}\right)^n\mu(-n-1)$, Z.T. is $|z| < 1/3$.

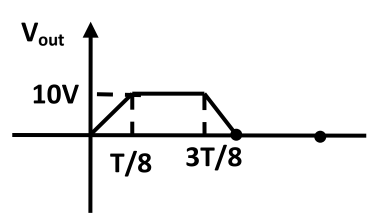
Intersection of ROCs is $\emptyset$.

Hence (D)

42. **[Ans .B]**
$y[n] = A\,x[n-n_0] = A\sin[\omega_0(n-n_0)+\emptyset]$
The group delay function,
$\frac{-d\theta(\omega)}{d\omega} = tg = n_0$ here
So, $d\theta(\omega) = -n_0\, d\omega / \omega=\omega_0$
$\therefore \theta(\omega) = -n_0\omega_0 + k^1$
To avoid phase change $k^1 = 2\pi k$
This form of $\theta(\omega)$ is called as unwrapped phase.

43. **[Ans .A]**
First we need to calculate the mobility of electron (μ_e) we know that drift velocity of hole is given by,
$V_{drift} = \mu_p E = \mu_p = \frac{V_{drift}}{E} = \frac{3\times10^5\,cm/sec}{1000\,v/cm} = 300\ cm^2/\text{v.sec}$
$\mu_e = 2\times\mu_p = 600cm^2/\text{v.sec}$
Resistivity is given by, $\rho = \frac{1}{q\mu_n n + q\mu_p n} \approx \frac{1}{q\mu_n n}$ $(since\ n \gg p)$
$\therefore \rho = \frac{1}{1.602\times10^{-14}\times600\times10^{17}} = 0.104\Omega cm$

44. **[Ans .C]**
T = Time period
Average value



$= \frac{1}{T}$[Area of Trapezoid] $= \frac{1}{T}\times\left[\frac{1}{2}\times\left(\frac{T}{2}+\frac{T}{4}\right)\times 10\right]$

=3.75 V

45. **[Ans .B]**

$E = I_m (E_s e^{j\omega t})$

$\rightarrow E_s = 20e^{j\beta z} a_y$, where $\omega = 10^8$ ---------------- (1)

$\nabla . E_s = \frac{\partial E_{ys}}{\partial y} = 0$

$\nabla \times E_s = -j\omega\mu H_s \rightarrow H_s = \frac{\nabla \times E_s}{-j\omega\mu}$

$= \frac{1}{-j\omega\mu}\left[-\frac{\partial E_{ys}}{\partial z} a_x\right] = -\frac{20\beta}{\omega\mu} e^{-j\beta z} a_x$

$\nabla \times H_s = j\omega t E_s . \rightarrow E_s = \frac{\nabla \times Hs}{j\omega t}$

$= \frac{1}{j\omega\mu}\left(\frac{\partial Hxs}{\partial z}\right) a_y = \frac{20\beta^2 e^{-j\beta^2}}{\omega^2\mu\epsilon} a_y$ ------ (2)

Comparing (1) and (2)

$20 = \frac{20\beta^2}{\omega^2\mu\epsilon} \Rightarrow \beta = \pm\omega\sqrt{\mu\epsilon} = \pm 1/3$

46. **[Ans .B]**

Solution: $\beta_1 = \frac{\omega}{C} = \frac{1}{3}$, $n_1 = n_0 = 120\pi \rightarrow$ for free space

$\beta_2 = \omega\sqrt{\mu\epsilon} = \frac{4}{3}$, $n_2 = 2n_0 \rightarrow$ for lossless dieelectric

Given: - $H_i = 10\cos(10^8 t - \beta_1 z) a_x$

$\Rightarrow E_{io} = 10\, n_o$

So $E_i = -10n_o \cos(10^8 t - \beta_1 z)\ a_x mv/m$

$\Gamma = \frac{n_2 - n_1}{n_2 + n_1} = \frac{1}{3} = \frac{E_i}{E_r} \Rightarrow E_r = \frac{E_i}{3}$

$E_r = -\frac{40}{3} n_o \cos(10^8 t - \frac{4}{3}z)\, a_y$ mv /m

$H_r = \frac{20}{3}\cos(10^8 t - \frac{4}{3}z)\, a_x$ mA /m

47. **[Ans .A]**

For A, poles are root of $s^2+5s-6=0$

∴ Poles are -6 & +1

∴ A is unstable

For B, $T(s) = \frac{\frac{4}{(s^2+5s-6)}}{1+\frac{4}{(s^2+5s-6)}\cdot\frac{(s-1)}{(2)}} = \frac{4}{(s^2+7s-8)}$

∴ Poles are roots of $s^2 + 7s - 8 = 0$

∴ Poles are – 8 & +1

∴B is unstable

Hence (A)

48. **[Ans .B],** $i_L(0) = 2A$, $V_C(0) = 2V$

$i_L(t) = 2e^{-t}$

$\frac{di_L(t)}{dt} = 2e^{-t}$, At $f = 0^+$ $\frac{di_L(t)}{dt}\Big|_{t=0^+} = -2$ A/S

Option (B)

49. **[Ans .C],** $\frac{dV_C}{dt}\Big|_{t=0^+} = -2$ V/sec $\frac{dI_L}{dt}\Big|_{t=0^+} = -2$ A/sec

$\frac{dv_c}{dI_L} = 1$

Hence (C)

50. **[Ans .D]**

The number of bits in the PCM system are,

n = 7 bits

$\left(\frac{S}{n}\right)_{dB}$ = 1.8 + 6n dB

= 43.8 dB.

51. **[Ans .C]**

Signaling rate is given by

$\gamma = \vartheta\, f_s$

$r = 56 \times 10^3$ and

$\vartheta = 7$ bits

$f_s = 8 \times 10^3$ Hz

$f_s \geq 2\, f_m$

$\therefore f_m \leq 4$ KHz

52. **[Ans .C],** Feed back factor $\beta = \frac{R_1}{R_1+R_2}$

Option (C)

53. **[Ans .C],** If open loop given $= A = 10^4$

A_f = closed loop given = $\frac{A}{1+A\beta}$

Now, $A_f = 10 = \frac{A}{1+A\beta}$; $\beta = \frac{\frac{A}{10}-1}{A}$

$\beta = \frac{R_1}{R_1+R_2} = \frac{1}{1+\frac{R_2}{R_1}} = \frac{10^3-1}{10^4} = \frac{999}{10^4}$

so, $1 + \frac{R_2}{R_1} = \frac{1}{999/10^4} = \frac{10^4}{999}$

so, $\frac{R_2}{R_1} = \frac{10^4}{999} - 1 = \frac{9001}{999} \approx 9.01$

Option (C)

54. **[Ans .B]**

Solution: $N = z^+ - p^+$

$N = -2,\ z^+ = 0,\ \therefore p^+ = 2$

Type of system = 2, $\therefore$ order = $2 + p^+ = 4$

Hence (B)

55. **[Ans .B],** root locus branches = |2 – P| =4

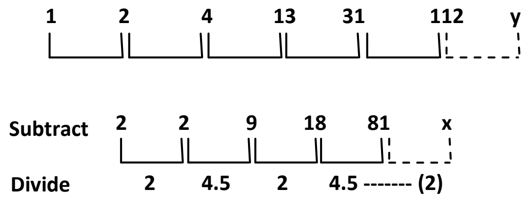
type of system is 2 $\Longrightarrow$ 2nd order pole at 0

root locus starts from open loop poles.

Hence from 0

$\therefore$ Hence (B)

56. **[Ans. D]**



$81 \times 2 = x$

$112 + 81 \times 2 = y = 274$

57. **[Ans. A]**

As the fruit seller is buying equal lots, we will have to make number of oranges of both the lots equal. Also, since he is selling all the orange, we will have to make the number of oranges brought and sold equal.

∴ L.C.M of 5, 4, 9 = 180.

The fruit seller is buying two lots of oranges, each lot having 180 oranges.

∴ 1^{st} lot = 36 Rs. ⇒ Total spent = 45 + 36 = 81 Rs.

2^{nd} lot = 45 Rs.

The fruit seller sells 9 oranges for 2 Rs. Therefore 560 Oranges for 80 Rs.

∴ Loss of 1 Rupee as loss % = $\frac{1}{81} \times 100 = 1.23\%$.

58. **[Ans. C]**

59. **[Ans. A]**

60. **[Ans. B]**

Choices A & C do not state the comparison logically. The expression ***as old as*** indicates equality of age, but the sentence indicates that the Brittany monuments predate the Mediterranean monuments by 2,000 years.

In B, the best choice, ***older than*** makes this point of comparison clear. B also correctly uses the adjective

61. **[Ans. C]**

62. **[Ans. B]**

63. **[Ans. B]**

In one day X can finish $1/15^{th}$ of the work

In one days Y can finish $1/10^{th}$ of the work.

Let us say that in one day Z can finish 1/2th of the work.

When all the three work together in one day they can finish $\frac{1}{15} + \frac{1}{10} + \frac{1}{z} = \frac{1}{5}$ of the work

$\therefore \frac{1}{2} = \frac{1}{30}$

$\therefore$ Ratio of efficiencies = $\frac{1}{5} : \frac{1}{10} : \frac{1}{30} = 2 : 3 : 1.$

$\therefore$ Z receives 1/6th of the total money.

$\therefore$ Accordingly money is divided as 240: 360 : 120.

$\Rightarrow$ Z = 120

64. **[Ans. D]**

The probability that a customer entered the store makes a purchase = 0.4.

$\Rightarrow$ 2 customers make a purchase and one does not is $(0.4)^2 \times 0.6$

The two of the three people can be selected in $^3c_2$ or 3 ways.

$\therefore$ Required probability = $3 \times 0.4^2 \times 0.6 = 0.288$.

65. **[Ans. C]**

$$\left.\begin{array}{ll} E_1, E_2, E_3 & \rightarrow \text{English men} \\ F_1, F_2, F_3 & \rightarrow \text{French men} \end{array}\right\} \quad \left.\begin{array}{l} 1.\ E_1 \leftrightarrow E_2 \\ E_2 \leftrightarrow E_3 \\ F_1 \leftrightarrow F_2 \\ F_2 \leftrightarrow F_3 \\ F_3 \leftrightarrow E_3 \\ E_3 \leftrightarrow E_2 \\ E_2 \leftrightarrow E_1 \\ F_3 \leftrightarrow F_2 \\ F_1 \leftrightarrow F_1 \end{array}\right\} \text{9 calls}$$