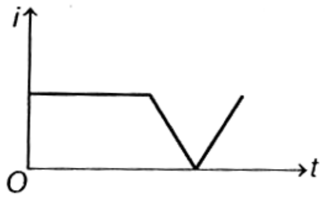
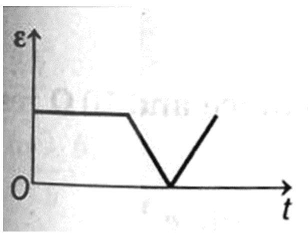
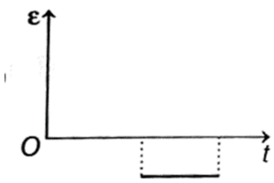
Max. Marks: 200 **Date: 04.09.2022**

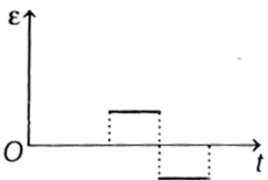
ARJUNA BATCH
PHYSICS : PART TEST
Topics: EMI and AC

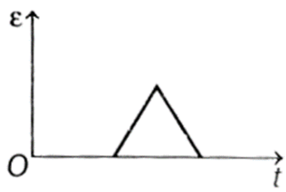
1. The current i in an induction coil varies with time t according to the graph shown in the figure. Which of the following graphs shows the induced emf (ε) in the coil with time?



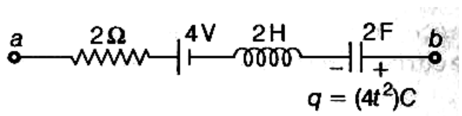
(a) 

(b) 

(c) 

(d) 

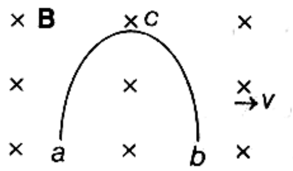
2. In the figure shown, V_{ab} at t = 1 s is



(a) 30 V (b) –30 V (c) 20 V (d) –20 V

Space for Rough Work

3. A semi-circular conducting ring acb of radius R moves with constant speed v in a plane perpendicular to uniform magnetic field B as shown in figure. Identify the correct statement.

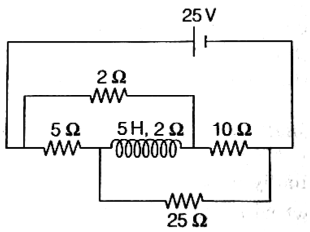


(a) $V_a - V_c = BRv$ (b) $V_b - V_c = BRv$ (c) $V_a - V_b = 0$ (d) None of these

4. In the figure shown, a T-shaped conductor moves with constant angular velocity ω in a plane perpendicular to uniform magnetic field B. The potential difference $V_A - V_B$ is

(a) zero (b) $\frac{1}{2}B\omega l^2$ (c) $2B\omega l^2$ (d) $B\omega l^2$

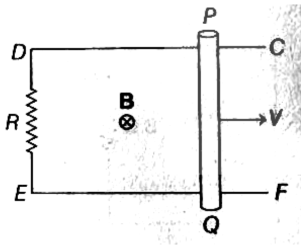
5. In the circuit shown, what is the energy stored in the coil at steady state?



(a) 21.3 J (b) 42.6 J (c) Zero (d) 213 J

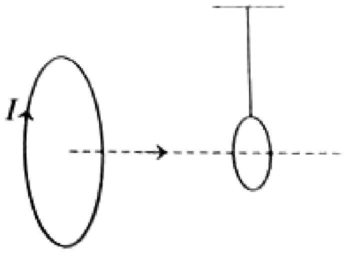
Space for Rough Work

6. A frame CDEF is placed in a region where a magnetic field B is present. A rod of length one metre moves with constant velocity 20 m/s and strength of magnetic field is one tesla. The power spent in the process is (take R = 0.2 Ω and all other wires and rod have zero resistance)



(a) 1 kW (b) 2 kW (c) 3 kW (d) 4 kW

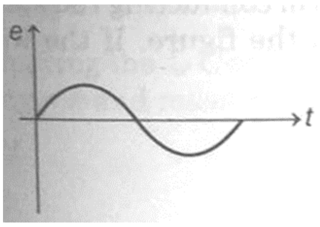
7. A small circular loop is suspended from an insulating thread. Another coaxial circular loop carrying a current I and having radius much larger than the first loop starts moving towards the smaller loop. The smaller loop will

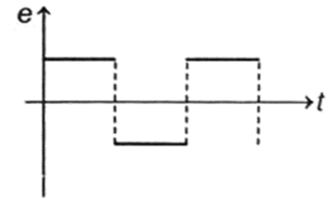


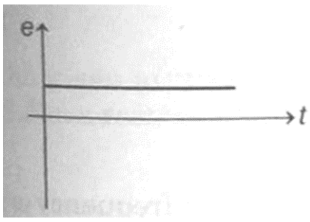
(a) be attracted towards the bigger loop (b) be repelled by the bigger loop
(c) experience no force (d) All of the above

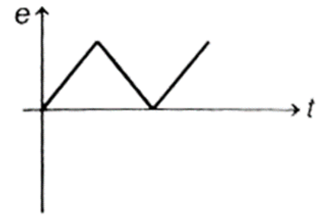
Space for Rough Work

8. A conducting rod is rotated about one end in a plane perpendicular to a uniform magnetic field with constant angular velocity. The correct graph between the induced emf (e) across the rod and time (t) is

(a) 

(b) 

(c) 

(d) 

9. A 3.56 H inductor is placed in series with a 12.8 Ω resistor. An emf of 3.24 V is then suddenly applied across the RL combination.

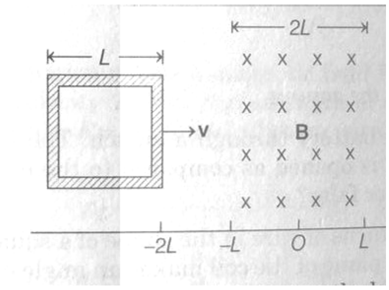
(a) At 0.278 s after the emf is applied what is the rate at which energy is being delivered by the battery

(b) At 0.278 s, at what rate is energy appearing as thermal energy in the resistor?

(c) At 0.278 s, at what rate is energy being stored in the magnetic field?

<u>Space for Rough Work</u>

10. A square loop of wire with resistance R is moved at constant speed v across a uniform magnetic field confined to a square region whose sides are twice the lengths of those of the square loop.



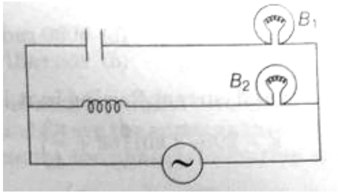
(a) Sketch a graph of the external force F needed to move the loop at constant speed, as a function of the coordinate x, from x = –2L to x = + 2L. (The coordinate x is measured from the centre of the magnetic field region to the centre of the loop. It is negative when the centre of the loop is to the left of the centre of the magnetic field region. Take positive force to be to the right)

(b) Sketch a graph of the induced current in the loop as a function of x. Take counterclockwise currents to be positive.

11. A loop of wire enclosing an area S is placed in a region where the magnetic field is perpendicular to the plane. The magnetic field B varies with time according to the expression $B = B_0e^{-at}$ where a is some constant. That is, at t = 0. The field is B_0 and for t > 0, the field decreases exponentially. Find the induced emf in the loop as a function of time.

Space for Rough Work

12. In the circuit shown in figure, if both the bulbs B_1 and B_2 are identical, then



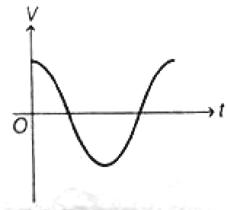
(a) Both bulbs have equal brightness

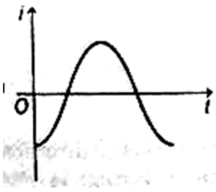
(b) B_2 will be brighter than B_2

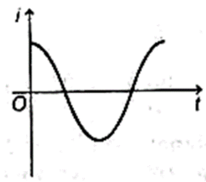
(c) As the frequency is increased, brightness of B_1 will increase and that of B_2 will decrease

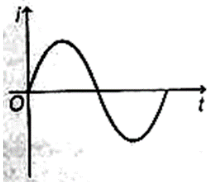
(d) As the frequency is decreased, the brightness of B_1 will increase and that of B_2 will decrease

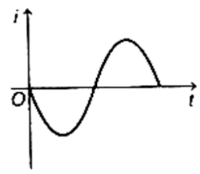
13. The figure represents the voltage applied across a pure inductor. The diagram which correctly represents the variation of current i with time t is given by



(a) 

(b) 

(c) 

(d) 

Space for Rough Work

14. A complex current wave is given by $i = (5 + 5 \sin 100\ \omega t)$A. Its average value over one time period is given as

(a) 10 A (b) 5 A (c) $\sqrt{50}$ A (d) 0

15. In a certain circuit current changes with time according to $i = 2\sqrt{t}$. Root mean square value of current between t = 2 to t = 4 s will be

(a) 3A (b) $3\sqrt{3}$ A (c) $2\sqrt{3}$ A (d) $\sqrt{3}$ A

16. Voltage applied to an AC circuit and current flowing in it is given by

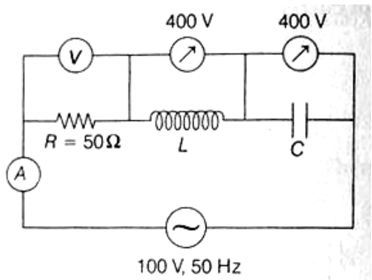
$$V = 200\sqrt{2} \sin\left(\omega t + \frac{\pi}{4}\right)$$

and $$i = -\sqrt{2} \cos\left(\omega t + \frac{\pi}{4}\right)$$

Then, power consumed in the circuit will be

(a) 200 W (b) 400 W (c) $200\sqrt{2}$ W (d) None of these

17. In the series L–C–R circuit, the voltmeter and ammeter readings are



(a) V = 100 V, I = 2 A (b) V = 100 V, I = 5 A

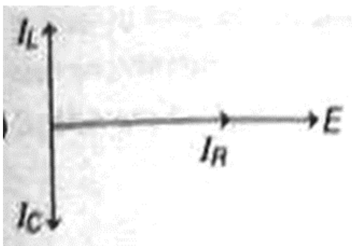
(c) V = 50 V, I = 2 A (d) V = 50 V, I = 1 A

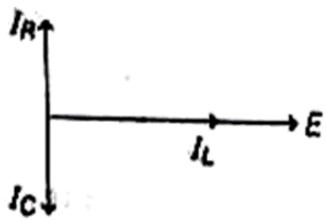
Space for Rough Work

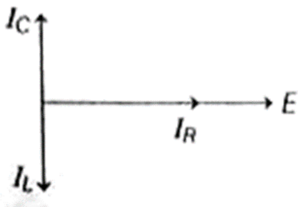
18. An AC voltage is applied across a series combination of L and R. If the voltage drop across the resistor and inductor are 20 V and 15 V respectively, then applied peak voltage is

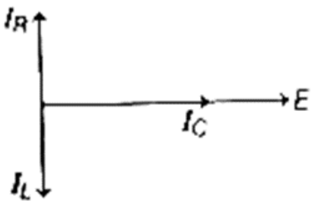
(a) 25 V (b) 35 V (c) $25\sqrt{2}$ V (d) $5\sqrt{7}$ V

19. An alternating emf is applied across a parallel combination of a resistance R, capacitance C and an inductance L. If I_R, I_L and I_C are the currents through R, L and C respectively, then the diagram which correctly represents, the phase relationship among I_R, I_L, I_C and source emf E, is given by

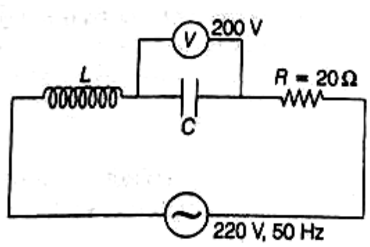
(a) 

(b) 

(c) 

(d) 

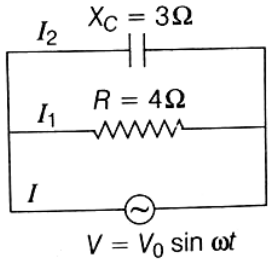
20. In the circuit shown rms current is 11 A. The potential difference across the inductor is



(a) 220 V (b) 0 V (c) 300 V (d) 200 V

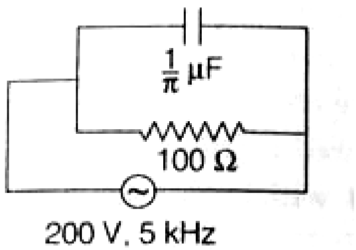
Space for Rough Work

21. A capacitor and resistor are connected with an AC source as shown in figure. Reactance of capacitor is $X_C = 3\ \Omega$ and resistance of resistor is $4\ \Omega$. Phase difference between current I and I_1 is $\left[\tan^{-1}\left(\frac{3}{4}\right) = 37°\right]$



(a) 90° (b) zero (c) 53° (d) 37°

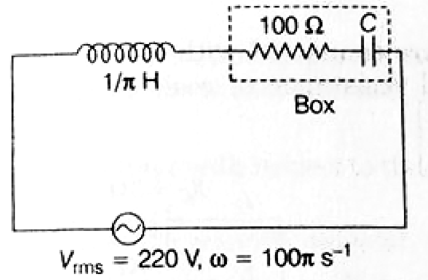
22. A signal generator supplies a sine wave of 200 V, 5 kHz to the circuit shown in the figure. Then, choose the wrong statement.



(a) The current in the resistive branch is 2.0 A
(b) The current in the capacitive branch is 0.126 A
(c) Total line current is = 2.83 A
(d) Current in both the branches is same

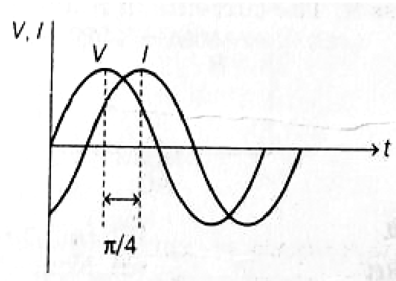
Space for Rough Work

23. For the circuit as shown in figure, if the value of rms current is 2.2 A, the power factor of the box is



(a) $\frac{1}{\sqrt{2}}$ (b) 1 (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{1}{2}$

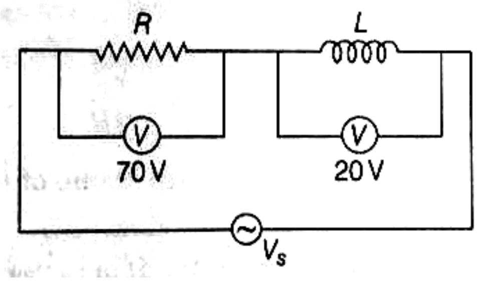
24. An AC voltage $V = V_0 \sin 100t$ is applied to the circuit, the phase difference between current and voltage is found to be $\pi / 4$, then



(a) $R = 100\ \Omega, C = 1\ \mu F$ (b) $R = 1\ k\Omega, C = 10\ \mu F$

(c) $R = 10\ k\Omega, L = 1\ H$ (d) $R = 1\ k\Omega, L = 10\ H$

25. The adjoining figure shows an AC circuit with resistance R, inductance L and source voltage V_s. Then,



(a) the source voltage $V_s = 72.8$ V

(b) the phase angle between current and source voltage is $\tan^{-1}(7/2)$

(c) Both (a) and (b) are correct

(d) Both (a) and (b) are wrong

Space for Rough Work

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PART-A

[SINGLE CORRECT CHOICE TYPE]

Q.1 to Q.10 has four choices (A), (B), (C), (D) out of which **ONLY ONE** is correct.

Q.1 $\int \left(\sin(101x)\cdot\sin^{99}x\right)dx$ equals

(A) $\dfrac{\sin(100x)(\sin x)^{100}}{100}+C$

(B) $\dfrac{\cos(100x)(\sin x)^{100}}{100}+C$

(C) $\dfrac{\cos(100x)(\cos x)^{100}}{100}+C$

(D) $\dfrac{\sin(100x)(\sin x)^{101}}{101}+C$

Q.2 $\int \dfrac{(2x^{12}+5x^9)}{(x^5+x^3+1)^3}dx$ is equal to

(A) $\dfrac{x^2+2x}{(x^5+x^3+1)}+c$

(B) $\dfrac{x^{10}}{2(x^5+x^3+1)^2}+c$

(C) $ln\left(x^5+x^3+1+\sqrt{2x^7+5x^4}\right)+c$

(D) None of these

Q.3 If $\int \dfrac{x^3-x^2+x-1}{x^5+1}dx = A\,ln\,|x^5+1|+B\,ln\,|x+1|+C$, then

(A) $5A+B=-1$ (B) $5A+B=0$ (C) $5A+B=1$ (D) $5A+B=-2$

Q.4 $\int \frac{e^x(x-1)(x-\ln x)}{x^2}\,dx$ is equal to

(A) $e^x\left(\frac{x-\ln x}{x}\right)+c$
(B) $e^x\left(\frac{x-\ln x+1}{x}\right)+c$
(C) $e^x\left(\frac{x-\ln x}{x^2}\right)+c$
(D) $e^x\left(\frac{x-\ln x-1}{x}\right)+c$

(where c is constant of integration)

Q.5 If $\int \frac{x^2-1}{x^3\sqrt{3x^4+2x^2-1}}\,dx = f(x)+C$, where $f(1)=-1$, then $|f(-1)|$ is equal to

(A) 1
(B) 2
(C) 3
(D) 4

Q.6 If $\int \frac{\left(\frac{1}{x^2}+\frac{1}{x}\right)(x-1)\,dx}{\left(\frac{1}{x^3}+\frac{1}{x}\right)\sqrt{(x^3-x^2+x)(x^3+x^2+x)}} = \sec^{-1}(f(x))+c \ (x>0)$ and $f(2)=\frac{5}{2}$ then the minimum value of $f(x)$ is equal to

(A) 1
(B) 2
(C) $\frac{5}{2}$
(D) $\frac{5}{4}$

Q.7 Given that $\int \frac{\sin^3 x - x\sin^2 x\cdot\cos x}{\cos^3 x}\,dx = f(x)+C$, where C is constant of integration.

If $f(\pi)=\frac{\pi^2}{2}$, then the value of $[f(2\pi)]$ equals

(A) 19
(B) 39
(C) 40
(D) 18

[**Note :** [k] denotes greatest integer function less than or equal to k.]

Q.8 If the value of $\int \frac{2(4x+3)}{2x(x+1)(2x+1)(2x+3)+5}dx = \frac{2}{3}\tan^{-1}\left(\frac{f(x)}{3}\right)+C$ and $f\left(\frac{\sqrt{5}-3}{4}\right)=0$, where C is constant of integration, then $f(1)$ is equal to

(A) 9 (B) 10 (C) 11 (D) 12

[PARAGRAPH TYPE]

Paragraph for question nos. 9 & 10

Let α, β, γ and δ be 4 distinct roots of the equation $x^4 - 4x + 3 = x\left(x^3 - f'(1)x^2 + f''(1)x - 4\right) + f(1)$ and $f(x)$ is a monic polynomial of degree 3.

Q.9 The value of $\lim\limits_{x\to 1}\frac{(x-1)^3 - \sin^3(x-1)}{\left(f(x)-3\right)^{5/3}}$ is

(A) $\frac{1}{2}$ (B) 2 (C) $\frac{1}{6}$ (D) $\frac{2}{3}$

Q.10 If $\int \frac{dx}{\frac{f(x)-3}{x-1}+4} = \frac{1}{2}g(x)+C$, where C is constant of integration and $g(3)=\frac{\pi}{4}$, then the value of $g(5)+g(7)$ is

(A) $\frac{\pi}{2}$ (B) $\frac{3\pi}{4}$ (C) π (D) $\frac{5\pi}{4}$

PART-A
[MULTIPLE CORRECT CHOICE TYPE]

Q.11 to Q.20 has four choices (A), (B), (C), (D) out of which **MORE THAN ONE** is correct.

Q.11 $\int \sqrt{1 + \csc x}\ dx$ equals

(A) $2 \sin^{-1} \sqrt{\sin x} + c$ (B) $\sqrt{2} \cos^{-1} \sqrt{\cos x} + c$
(C) $c - 2 \sin^{-1} (1 - 2 \sin x)$ (D) $\cos^{-1} (1 - 2 \sin x) + c$

Q.12 If $\int e^u \cdot \sin 2x\ dx$ can be found in terms of known functions of x then u can be
(A) x (B) $\sin x$ (C) $\cos x$ (D) $\cos 2x$

Q.13 $\int \frac{\ell n (\tan x)}{\sin x\ \cos x}\ dx$ equal

(A) $\frac{1}{2} \ln^2 (\cot x) + c$ (B) $\frac{1}{2} \ln^2 (\sec x) + c$

(C) $\frac{1}{2} \ln^2 (\sin x\ \sec x) + c$ (D) $\frac{1}{2} \ln^2 (\cos x\ \operatorname{cosec} x) + c$

Q.14 If $\int \frac{\sin x}{\sin(x - \alpha)} dx = Ax + B \log \sin (x - \alpha) + C$ then
(A) $A = \sin \alpha$ (B) $B = \cos \alpha$ (C) $A = \cos \alpha$ (D) $B = \sin \alpha$

Q.15 $\int x^{-2/3} (1 + x^{1/2})^{-5/3}$ is equal to
(A) $3\ (1 + x^{-1/2})^{-1/3} + c$ (B) $3\ (1 + x^{-1/2})^{-2/3} + c$
(C) $3\ (1 + x^{1/2})^{-2/3} + c$ (D) None of these

Q.16 If $\int \frac{4e^{x}+6e^{-x}}{9e^{x}-4e^{-x}}, dx = Ax + B\log_e(9e^{2x}-4)+C$ then

(A) $A=\frac{3}{2}$ (B) $B=\frac{35}{36}$ (C) C is indefinite (D) $A+B=-\frac{19}{36}$

Q.17 If $\int \frac{x^{1/2}}{\sqrt{1-x^3}}\,dx = \frac{2}{3}\,gof(x)+c$ then

(A) $f(x)=\sqrt{x}$ (B) $f(x)=x^{3/2}$ (C) $f(x)=x^{2/3}$ (D) $g(x)=\sin^{-1}x$

Q.18 $\int \frac{\cos 4x+1}{\cot x-\tan x}dx$ is equal to

(A) $-\frac{1}{2}\cos 4x+c$ (B) $-\frac{1}{4}\cos 4x+c$ (C) $-\frac{1}{2}\sin 2x+c$ (D) $\frac{1}{8}\cos(4x)+c$

Q.19 A curve $g(x)=\int x^{27}(1+x+x^2)^6(6x^2+5x+4)dx$ is passing through $(0,0)$ then

(A) $g(1)=\frac{3^7}{7}$ (B) $g(1)=\frac{2^7}{7}$ (C) $g(-1)=\frac{1}{7}$ (D) $g(-1)=\frac{3^7}{14}$

Q.20 If $\int \frac{\sqrt{x^2+4x+3}}{x+2}\,dx = A\sqrt{x^2+4x+3} + B\tan^{-1}\sqrt{x^2+4x+3} + C$, then

(A) $A+B=0$ (B) $A+B=1$ (C) $A+2B=3$ (D) $2A+B=1$

[MATCHING LIST TYPE]

Q.21 is Matching List type questions. Each question has matching lists. Write your Answer.

Q.21

	Column-I		Column-II
(A)	$\int \frac{x^2(x^6+x^5-1)\,dx}{(2x^6+3x^5+2)^2}$	(P)	$\frac{1}{6}\left(\frac{1}{x^{-3}}+\frac{3}{x^{-2}}\right)^{\frac{1}{2}}+C$
(B)	$\int \frac{(x^5+x^4+x^2)\,dx}{\sqrt{4x^7+5x^6+10x^4}}$	(Q)	$\frac{1}{2}(1+x^{-2}+x^{-5})^{-2}+C$
(C)	$\int \frac{(2x^{12}+5x^9)dx}{(x^5+x^3+1)^3}$	(R)	$\frac{-1}{6}(2x^3+3x^2+2x^{-3})^{-1}+C$
	(where C is the constant of integration.)	(S)	$x\left(\frac{x^3}{25}+\frac{x^2}{20}+\frac{1}{10}\right)^{\frac{1}{2}}+C$

PART-C

[INTEGER TYPE]

Q.22 to Q.25 are "Integer Type" questions. (The answer to each of the questions **are** **<u>single digits</u>**)

[INTEGER TYPE]

Q.22 Let $\int \frac{f'(x)g(x) - g'(x)f(x)}{\left(f(x)+g(x)\right)\sqrt{f(x)g(x) - g^2(x)}}dx = \sqrt{m}\tan^{-1}\left(\sqrt{\frac{f(x)-g(x)}{ng(x)}}\right) + C$,

where $m, n \in N$ and 'C' is constant of integration $\left(g(x) > 0\right)$. Find the value of $(m^2 + n^2)$.

Q.23 $\int \frac{e^{3x}}{(1+e^x)^3}dx = ln(1+e^x) + \frac{2}{f(x)} - \frac{1}{2(1+e^x)^2} + c$. Find value of $f'(0)$?

Q.24 $\int \frac{\cos(ln\,x)}{x^3}dx = \frac{1}{ax^2}\left[b\sin(ln\,x) - c\cos(ln\,x)\right] + k$. Find the value of $a+b+c$?

Q.25 $\int \frac{1}{x^3(1+x^2)}dx = \frac{1}{2}\left[ln\ f(x) - g(x)\right] + c$. Find number of solution of equation $f(x) = g(x)$?

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Max. Marks: 200 **Date: 04.09.2022**

ARJUNA BATCH
PHYSICS : PART TEST
Topics: EMI and AC

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

MATHEMATICS : PART TEST
Topics: Indefinite Integration

26.	(a)	27.	(b)	28.	(b)	29.	(d)	30.	(a)
31.	(b)	32.	(a)	33.	(c)	34.	(a)	35.	(b)
36.	(a, d)	37.	(a,b,c,d)	38.	(a,c,d)	39.	(c,d)	40.	(b)
41.	(b,c,d)	42.	(b,d)	43.	(d)	44.	(a,c)	45.	(a,d)
46.	(a-R, b-S, c-Q)	47.	(8)	48.	(1)	49.	(8)	50.	(0)