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Lockdown Period Open Practice Test Series

(Also useful for ESE & Other Exams)

EE : ELECTRICAL ENGINEERING

TEST No. 12 | MICRO PROCESSOR & EMT

Read the following instructions carefully

1. This question paper contains 33 MCQ's & NAQ's. Bifurcation of the questions are given below:

Subjectwise Test Pattern

Questions	Question Type	No. of Questions	Marks	Total Marks	Negative Marking
1 to 9	Multiple Choice Ques.	9	1	9	0.33
10 to 16	Numerical Answer Type Ques.	7	1	7	None
17 to 25	Multiple Choice Ques.	9	2	18	0.66
26 to 33	Numerical Answer Type Ques.	8	2	16	None
Total Questions : 33		**Total Marks : 50**		**Total Duration : 90 min**	

2. Choose the closest numerical answer among the choices given.

Multiple Choice Questions : Q.1 to Q.9 carry 1 mark each

Q.1 Eight memory chips of size 64 × 8 bits have their address buses connected together. The size of resultant memory is

(a) 64 × 64 bits
(b) 128 × 32 bits
(c) 256 × 16 bits
(d) 512 × 8 bits

1. (a)

$$\text{Memory chip size} = 2^6 \times 8$$

$$6 \rightarrow \text{address lines}$$

and $$8 \rightarrow \text{data lines}$$

When eight memory chips of size $2^6 \times 8$ have their address buses connected together. The address lines will be same but data lines become 8 × 8. So, overall size of resultant memory becomes 64 × 64 bits.

Q.2 What is the difference between I/O mapped I/O and memory mapped I/O.

(a) in case of I/O mapped 8 bit address is used to identify I/O while in case of memory mapped I/O 16 bit address is used.
(b) in case of I/O mapped 16 bit address is used while in case of memory mapped, 8 bit address is used.
(c) both of them use 8 bit address.
(d) both of them use 16 bit address.

2. (a)

In case of I/O mapped I/O, 8 bit address is used to identify I/O while in case of memory mapped I/O 16 bit address is used to identify I/O.

Q.3 An instruction of the 8085 microprocessor that requires both memory read and memory write machine cycles is

(a) RST1
(b) ADD M
(c) MVI M, 8F
(d) LHLD 8044

3. (c)

Machine cycles → F R W

MVI M, 8F requires both memory read and memory write machine cycles, microprocessor first reads the data 8F from memory and then write the same at memory location whose address is stored in HL pair.

Q.4 Which of the following methods could be used for I/O operation in an 8085 microprocessor?

1. DMA
2. Interrupting
3. Hand shaking

Select the correct answer using the codes given below:

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

4. (c)

Hand shaking is used in asynchronous data transfer between microprocessor and I/O devices and DMA is used for direct data transfer between memory and I/O device. Interrupt can be an external signal / instruction, which may alter sequence of execution of microprocessor.

Q.5 Consider the following statements regarding interrupts.

A. Vector address of TRAP is (0028) H

B. Certain I/O devices can make INTR interrupts as edge triggered.

Choose the correct option if T = True and F = False.

	A	B
(a)	T	T
(b)	F	F
(c)	F	T
(d)	T	F

5. (b)

Trap is also called as RST 4.5

$$\text{Vector address} = (4.5 \times 8)_{10} = (36)_{10} = (24)_H = (0024)_H$$

INTR is a level triggered interrupt.

Q.6 The attenuation constant α for a distortionless transmission line is

(a) $\alpha = 0$

(b) $\alpha = R\sqrt{\frac{C}{L}}$

(c) $\alpha = R\sqrt{\frac{L}{C}}$

(d) None of the above

6. (b)

For a distortionless line

$$\frac{R}{L} = \frac{G}{C}$$

$$\alpha = \sqrt{RG} = \sqrt{R\left(\frac{RC}{L}\right)} = R\sqrt{\frac{C}{L}}$$

Q.7 Given that $\vec{D} = \frac{\theta}{\pi r^2}(1-\cos 3r)\hat{a}_r$ in spherical coordinates, the charge density is

(a) zero

(b) $\frac{3\theta}{\pi r^2}$

(c) $\frac{3\theta}{\pi r^2}\sin 3r$

(d) $\frac{2\theta}{\pi r^2}\sin 3r$

7. (c)

$$\nabla \cdot \vec{D} = \rho$$

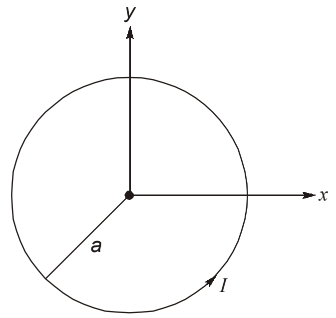
$$\frac{1}{r^2}\cdot\frac{\partial}{\partial r}\left(\frac{r^2\theta}{\pi r^2}(1-\cos 3r)\right) = \rho$$

$$\frac{1}{r^2}\cdot\frac{\partial}{\partial r}\left(\frac{\theta}{\pi}(1-\cos 3r)\right) = \rho$$

$$\frac{\theta}{r^2\pi}\left(\frac{\partial}{\partial r}(-\cos 3r)\right) = \rho$$

$$\rho = \frac{3\theta}{r^2\pi}\sin 3r$$

Q.8 A circular loop of radius a, centered at origin and lying in the xy plane, carries current I as shown in the figure.



The magnetic field intensity at the center of the loop will be

(a) $\frac{I}{2a}\hat{a}_z$ (b) $-\frac{I}{2a}\hat{a}_z$

(c) $\frac{I}{4a}\hat{a}_z$ (d) $\frac{2I}{a}\hat{a}_z$

8. (a)

The magnetic field intensity produced due to a small current element $I\,dl$ is defined as

$$d\vec{H} = \frac{I\,dl \times \hat{a}_R}{4\pi R^2}$$

where dl is the differential line vector and $\hat{a}_R$ is the unit vector directed towards the point where field is to be determined. So for the circular current carrying loop, we have

$$dl = a\,d\phi\,\hat{a}_\phi$$

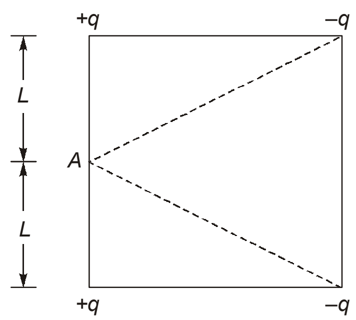
$$\hat{a}_R = -\hat{a}_\rho$$

Therefore the magnitude field intensity produced at the center of the circular loop is

$$\vec{H} = \int_{\phi=0}^{2\pi} \frac{Iad\phi\hat{a}_\phi \times (-\hat{a}_P)}{4\pi a^2} = \frac{I_a}{4\pi a^2}[\phi]_0^{2\pi}\,\hat{a}_z$$

$$= \frac{I}{2a}\hat{a}_z \text{ A/m}$$

Q.9 Four electric charges $+q$, $+q$, $-q$, $-q$ are placed at the corners of a square of side $2L$ as shown below.



The electric potential at point A, mid way between the two charges $+q$ and $+q$ is

(a) zero (b) $\frac{1}{4\pi\epsilon_0}\cdot\frac{2q}{L}\left(1+\frac{1}{\sqrt{5}}\right)$

(c) $\frac{1}{4\pi\epsilon_0}\cdot\frac{2q}{L}\left(1-\frac{1}{\sqrt{5}}\right)$ (d) $\frac{1}{4\pi\epsilon_0}\cdot\frac{2q}{L}\left(1+\sqrt{5}\right)$

9. (c)

$$V = \frac{kq_1}{L_1} + \frac{kq_2}{L_2} + \frac{kq_3}{L_3} + \frac{kq_4}{L_4}$$

$$q_1 = q \qquad L_1 = L$$

$$q_2 = q \qquad L_2 = L$$

$$q_3 = -q \qquad L_3 = \sqrt{5}L$$

$$q_4 = -q \qquad L_4 = \sqrt{5}L$$

$$V = \frac{1q}{4\pi\epsilon_0}\left(\frac{1}{L} + \frac{1}{L} - \frac{1}{\sqrt{5}L} - \frac{1}{\sqrt{5}L}\right) = \frac{1}{4\pi\epsilon_0}\cdot\frac{2q}{L}\left(1 - \frac{1}{\sqrt{5}}\right)$$

Numerical Answer Type Questions : Q. 10 to Q. 16 carry 1 mark each

Q.10 The no. of T-states required to execute instruction IN 8-bit address are ________ T-states.

10. (10)

Machine cycles → F R IOR
4 3 3 → 10 → Total T-states.

Q.11 The total no. of memory accesses involved when the instruction LHLD 2000 is executed by 8085 microprocessor is _________ .

11. (5)

Machine cycle → F R R R R
4 3 3 3 3 → 16 → T-state

Total five memory accesses are involved when the instruction LHLD 2000 is executed by the microprocessor One op-code fetch cycle and four memory read cycles.

Q.12 Consider the following 8085 program

```
MVI C, 73 H
MVI B, 57 H
MOV A, C
MOV A, B
MOV C, A
MVI D, 37 H
OUT PORT 1
HLT
```

The output at PORT 1 is ______ H.

12. (57)

MVI C, 73 H	; C ← 73 H		
MVI B, 57 H	; B ← 57 H		
MOV A, C	; A ← C	⇒	A = 73 H
MOV A, B	; A ← B	⇒	A = 57 H
MOV C, A	; C ← A	⇒	C = 57 H
MVI D, 37 H	; D ← 37 H		
OUT PORT 1	; PORT 1 ← 57 H		
HLT	; Halt		

57 H goes out from the microprocessor accumulator to PORT 1

Q.13 When a load resistance R_L is connected to a lossless transmission line of characteristic impedance 75 Ω, it results in a VSWR of 2. The load resistance is ________ Ω.

13. (150)

$$\text{VSWR} = 2$$

$$\Gamma = \frac{2-1}{2+1} = \frac{1}{3}$$

$$\frac{1}{3} = \frac{Z_L - Z_0}{Z_L + Z_0}$$

Z_0 is given 75 Ω

$$\frac{1}{3} = \frac{Z_L - 75}{Z_L + 75}$$

$$Z_L + 75 = 3Z_L - 225$$

$$2Z_L = 300$$

$$Z_L = 150\ \Omega$$

Q.14 Given $\vec{A} = yz\hat{a}_x + xy\hat{a}_y + xz\hat{a}_z$, $|\nabla \times \vec{A}|$ at the point $P(0, 1, 2)$ is ________.

14. 1.41 (1.30 to 1.50)

Given,
$$\vec{A} = yz\hat{a}_x + xy\hat{a}_y + xz\hat{a}_z$$

$$\nabla \times \vec{A} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ yz & xy & xz \end{vmatrix}$$

$$\nabla \times \vec{A} = \hat{a}_x(0-0) - \hat{a}_y(z-y) + \hat{a}_z(y-z)$$

$$= -\hat{a}_y(z-y) + \hat{a}_z(y-z)$$

At point (0, 1, 2)

$$\nabla \times \vec{A} = -\hat{a}_y(2-1) + \hat{a}_z(1-2)$$

$$\nabla \times \vec{A} = -\hat{a}_y - \hat{a}_z$$

$$|\nabla \times \vec{A}| = \sqrt{1^2 + 1^2} = \sqrt{2} = 1.41$$

Q.15 Two conducting spherical shells have radii of $a = 2$ cm and $b = 5$ cm. The interior is a perfect dielectric for which $\epsilon_R = 10$. The capacitance C is = ________ pF.

15. 37.08 (36.50 to 37.50)

Here spherical shells of radii $a = 2$ cm and $b = 5$ cm and relative permittivity is $\epsilon_R = 10$.

The capacitance of concentric spherical shells is

$$C = \frac{4\pi\epsilon_0\epsilon_R}{\frac{1}{a} - \frac{1}{b}}$$

$$= \frac{4\pi \times 8.854 \times 10^{-12} \times 10}{\frac{1}{0.02} - \frac{1}{0.05}}$$

$$= 37.08 \text{ pF}$$

Q.16 The magnitude of the magnetic flux density in a material for which, the magnetization is 2.8 A/m and magnetic susceptibility is 0.0025 is ________ mT.

16. 1.411 (1.20 to 1.60)

Given, Magnetization, $M = 2.8$ A/m,

$$\chi_m = 0.0025$$

The magnetic field intensity in a material,

$$H = \frac{M}{\chi_m} = \frac{2.8}{0.0025} = 1120 \text{ A/m}$$

The flux density, $B = (1+\chi_m)\mu_0 H$

$$= (1+0.0025)\times 4\pi \times 10^{-7} \times 1120$$

$$= 1.411 \text{ mT}$$

Multiple Choice Questions : Q.17 to Q.25 carry 2 marks each

Q.17 Which of the following instructions can be used for multiplication of content of Accumulator by 2.

(a) 2050 : MVI A, 30H
2052 : LXI H, 2051H
2055 : ADD M
2056 : HLT

(b) MVI A, 30H
MVI B, 20H
ADD B
HLT

(c) MOV A, B
MOV B, C
ADD B
HLT

(d) MOV A, B
ADD M
HLT

17. (a)

2050 : MVI A, 30H $\rightarrow$ A = $(30)_H$

2052 : LXI H, 2051H $\rightarrow$ HL = $(2051)_H$

2055 : ADD M

Content at memory location pointed by content of HL pair i.e. $(2051)_H$ is added to A and data at $(2051)_H$ is 30H. So after addition, content of A will become double.

Q.18 The following sequence of instructions are executed by an 8085 microprocessor:

1000 LXI SP, 27FF
1003 CALL 1006
1006 POP H.

After the completion of execution of these instructions, what are the contents of SP and the register H-L pair?

(a) SP = 27FD, HL = 1003
(b) SP = 27FF, HL = 1003
(c) SP = 27FD, HL = 1006
(d) SP = 27FF, HL = 1006

18. (d)

In CALL $\rightarrow$ SP decremented by '2'

In POP $\rightarrow$ SP incremented by '2'

So, from the given program, "SP" will not be affected after final execution and content of HL pair is same as that of initial content of SP.

$\therefore$ SP = 27FF H

and HL = 1006 H

Q.19 Consider the following 8085 microprocessor code;

```
LDA 7500 H
CMA
INR A
STA 7500 H
HLT
```

Choose the best option regarding the code;

(a) Contents in accumulator are two's complemented.
(b) Contents in accumulator are one's completmented.
(c) Contents in location 7500 H are one's complemented.
(d) Contents in location 7500 H are two's complemented.

19. (d)

LDA 7500 H	;	Load the contents in location 7500 H to accumulator.
CMA	;	Complement accumulator is performed.
INR A	;	Increment A by one ($A \rightarrow A + 1$ H) i.e. 2's compliment.
STA 7500 H	;	Store contents of accumulator to memory location 7500 H.
HLT	;	Halt the program

Contents in location 7500 H are two's complemented.

Q.20 Contents of flags when following program is executed is

```
LXI SP, 9000 H
LXI H, 005D H
PUSH H
POP PSW
HLT
```

(a) S = 0, Z = 1, AC = 1, P = 1 and CY = 1
(b) S = 0, Z = 1, AC = 0, P = 1 and CY = 0
(c) S = 0, Z = 0, AC = 1, P = 1 and CY = 1
(d) S = 0, Z = 0, AC = 0, P = 1 and CY = 0

20. (a)

LXI SP, 9000 H	;	$SP \leftarrow 9000$
LXI H, 005D H	;	$HL \leftarrow 005D$
PUSH H	;	SP = SP – 2 = 8FFE H
POP PSW	;	Pop the contents 005D onto PSW register.

In pop PSW $\rightarrow$ SP $\rightarrow$ SP + 2

i.e. 2 B on top of stack is accessed into 'A and F'

PSW = | A | F | = | 00 | 5D |

Flag register =

0	1	0	1	1	1	0	1
S	Z		AC		P		CY

Q.21 In 8085 processor, the RST 5 instruction transfers the program execution to the following location.

(a) 30 H
(b) 24 H
(c) 28 H
(d) 48 G

21. (c)

$$\text{Vector address} = (5 \times 8)_{10}$$
$$= (40)_{10} = (28)_H$$

Q.22 Consider the following instructions

EI
MVI B, 24H
MOV C, B
MOV A, C
MVI A, 4EH
SIM

After the code is executed,

(a) interrupt flag is set, RST 6.5 and RST 5.5 are masked.
(b) interrupt flag is set, RST 5.5 is masked.
(c) interrupt flag is reset, RST 7.5 and RST 6.5 are disabled.
(d) interrupt flag is set, RST 7.5 and RST 6.5 are masked.

22. (d)

For EI $\to$ IE flag is set DI; IE $\to$ 0

After executing SIM instruction, accumulator set-up for the SIM instruction is shown as,

SOD	SDE	X	R 7.5	MSE	M 7.5	M 6.5	M 5.5
0	1	0	0	1	1	1	0

As MSE is enabled, M 7.5 and M 6.5 are masked.

Q.23 If $\vec{F}(\rho,\phi,z) = \rho\hat{a}_\rho + \rho\sin^2\phi\,\hat{a}_\phi - z\hat{a}_z$, which one of the following is correct?

(a) $\nabla\cdot\vec{F}\Big|_{\phi=0} < \nabla\cdot\vec{F}\Big|_{\phi=\frac{\pi}{2}}$

(b) $\nabla\cdot\vec{F}\Big|_{\phi=\frac{\pi}{4}} = \nabla\cdot\vec{F}\Big|_{\phi=0}$

(c) $\nabla\cdot\vec{F}\Big|_{\phi=0} > \nabla\cdot\vec{F}\Big|_{\phi=\frac{\pi}{2}}$

(d) $\nabla\cdot\vec{F}\Big|_{\phi=\frac{\pi}{4}} = 2\nabla\cdot\vec{F}\Big|_{\phi=0}$

23. (d)

Given,

$$\vec{F}(\rho,\phi,z) = \rho\hat{a}_\rho + \rho\sin^2\phi\,\hat{a}_\phi - z\hat{a}_z$$

$$\nabla\cdot\vec{F} = \frac{1}{\rho}\frac{\partial}{\partial\rho}(\rho F_\rho) + \frac{1}{\rho}\frac{\partial F_\phi}{\partial\phi} + \frac{\partial F_z}{\partial z}$$

$$= \frac{1}{\rho}\left[\frac{\partial}{\partial\rho}\rho^2 + \frac{\partial}{\partial\phi}\rho\sin^2\phi + \frac{\partial\rho}{\partial z}(-z)\right]$$

$$= \frac{1}{\rho}[2\rho + 2\rho\sin\phi\cos\phi - \rho] = \frac{1}{\rho}[\rho + \rho\sin 2\phi]$$

$$\nabla\cdot\vec{F} = 1 + \sin 2\phi$$

$$\nabla\cdot\vec{F}\Big|_{\phi=\frac{\pi}{4}} = 1 + 1 = 2$$

$$\nabla\cdot\vec{F}\Big|_{\phi=0} = 1$$

$$\therefore \quad \nabla\cdot\vec{F}\Big|_{\phi=\frac{\pi}{4}} = 2\nabla\cdot\vec{F}\Big|_{\phi=0}$$

Q.24 For a homogeneous and isotropic medium with a charge density ρ and dielectric constant $\in$, the Poisson's equation for electrical potential V is

(a) $\nabla^2 V = \frac{\rho}{\in}$

(b) $\nabla^2 V = -\frac{\rho}{\in}$

(c) $\nabla \cdot V = \frac{\rho}{\in}$

(d) $\nabla \cdot V = -\frac{\rho}{\in}$

24. (b)

From Gauss's law

$$\nabla \cdot \vec{D} = \rho_V$$

$$\vec{D} = \in \vec{E}$$

So, $$\nabla.(\in \vec{E}) = \rho_V$$

Since medium is homogeneous and isotropic, so

$$\nabla \cdot \vec{E} = \frac{\rho_V}{\in}$$

Also, $$\vec{E} = -\frac{\partial V}{\partial r} = -\nabla V$$

$$\nabla \cdot (-\nabla V) = \frac{\rho_V}{\in}$$

$$\nabla^2 V = -\frac{\rho_V}{\in}$$

Q.25 A charge of uniform density $\rho_s = \left(\frac{7}{22}\right)$ nC/m^2 covers the plane $2x - 2y + z = 5$, $\vec{E}$(Electric field intensity) on the side containing the origin is

(a) $-12\hat{a}_x - 12\hat{a}_y + 6\hat{a}_z$

(b) $-12\hat{a}_x + 12\hat{a}_y - 6\hat{a}_z$

(c) $12\hat{a}_x - 12\hat{a}_y + 6\hat{a}_z$

(d) $12\hat{a}_x + 12\hat{a}_y + 6\hat{a}_z$

25. (b)

$$\hat{a}_n = \frac{A\hat{a}_x + B\hat{a}_y + C\hat{a}_z}{\sqrt{A^2 + B^2 + C^2}}$$

Electric field intensity, $$\vec{E} = \frac{\rho_s}{2\in_0}\hat{a}_n$$

$$= \frac{7 \times 10^{-9}}{22 \times 2 \times 8.854 \times 10^{-12}}\hat{a}_n$$

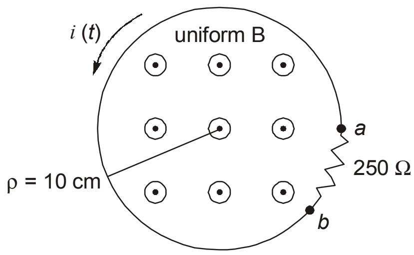
$$\vec{E} = 18\,\hat{a}_n = \frac{18(2\hat{a}_x - 2\hat{a}_y + \hat{a}_z)}{\sqrt{4+4+1}}$$

$$= 12\hat{a}_x - 12\hat{a}_y + 6\hat{a}_z$$

$$\vec{E}(\text{containing origin}) = -12\hat{a}_x + 12\hat{a}_y - 6\hat{a}_z$$

Numerical Answer Type Questions : Q. 26 to Q. 33 carry 2 marks each

Q.26 Consider the figure shown below. Let $B = 10 \cos 120\pi t$ Wb/m^2 and assume that the magnetic field produced by $i(t)$ is negligible.



If $V_{emf} = A \sin 120\,\pi t$ (Volts), then the value of A is ________ .

26. **118.43 (118.30 to 118.60)**

Emf induced in the loop due to the magnetic flux density is

$$V_{emf} = -\frac{\partial \phi}{\partial t}$$

$$= -\frac{\partial}{\partial t}(10\cos 120\pi t)(\pi\rho^2)$$

$$= \pi^2 \times (10 \times 10^{-2})^2 \times 120(10 \sin 120\pi t)$$

$$V_{emf} = 12\pi^2 \sin 120\,\pi t$$

Q.27 An 8085 assembly language program is given below:

```
MVI A, 57 H
MVI B, 0F H
ADD B
ANI FA H
CPI 9F H
STA C100 H
HLT
```

The contents at memory location C100 is ______ H.

27. **(62)**

MVI A, 57 H ; $A \leftarrow 57$ H

MVI B, 0F H ; $B \leftarrow 0F$ H

ADD B ; $A \leftarrow A + B$

$A = 66$ H

ANI FAH ; $A = 62$ H

$$\begin{array}{r} 1111\ 1010 \\ 0110\ 0110 \\ \text{ANI} \rightarrow \overline{0110\ 0010} \\ \overline{6 \quad\ 2\text{H}} \end{array}$$

CPI 9F H ; Compare 9F H with contents of A

STA C100 H ; Store 62 H in memory location C100 H

HLT ; HALT

Q.28 If the memory chip size is 256 × 1 bits. The number of chips required to make up 1 kB of memory is ________ .

28. (32)

$$\text{Size of one memory chip} = 256 \times 1 \text{ bits}$$
$$\text{Required memory size} = 1 \text{ kB}$$
$$\text{Total chips required} = \frac{1024 \times 8}{256 \times 1} = 32$$

Q.29 A charge $Q_2 = 8.854 \times 10^{-9}$ C is located in a vaccum at P_2 (2, 3, 1). The force on Q_2 due to a charge $Q_1 = 4\pi \times 10^{-3}$C at P_1 (2, 2, 1) is __________ $\hat{a}_y N$.

29. (1)

$$r = \sqrt{(2-2)^2 + (3-2)^2 + (1-1)^2}$$
$$= 1 \cdot \hat{a}_y$$
$$F = \frac{1}{4\pi\epsilon_0} \cdot \frac{Q_1 \cdot Q_2}{|r|^2} \cdot \frac{\vec{r}}{|\vec{r}|}$$
$$= \frac{4\pi \times 10^{-3} \times 8.854 \times 10^{-9}}{4\pi \times 8.854 \times 10^{-12}} \cdot \frac{\vec{r}}{|r|}$$
$$F = 1 \cdot \hat{a}_y \text{ N}$$

Q.30 A parallel plate capacitor of 100 pF having an air dielectric is charged to 10 kV. It is then electrically isolated. The plates are pulled away from each other until the distance is ten times more than before. The energy needed to pull the plates is ________ mJ.

30. 4.5 (4.30 to 4.60)

$$E_1 = \frac{1}{2} C_1 V_1^2$$
$$= \frac{1}{2} \times 100 \times 10^{-12} \times (10000)^2$$
$$= 5 \times 10^{-3} \text{ J}$$
$$E_2 = \frac{1}{2} C_2 V_2^2 \text{ in this case, capacitance is inversely proportional to distance.}$$
$$C \propto \frac{1}{d}$$
$$\therefore \quad \frac{C_1}{C_2} = \frac{d_2}{d_1}$$
$$\frac{C_1}{10} = C_2$$
$$E_2 = \frac{1}{2} \times \left(10 \times 10^{-12}\right) \times (10000)^2$$
$$= 5 \times 10^{-4} \text{ J}$$
$$\therefore \quad \Delta E = E_1 - E_2$$
$$= (5 \times 10^{-3}) - (5 \times 10^{-4})$$
$$\Delta E = 4.5 \text{ mJ}$$

Q.31 Given $\vec{J} = \frac{50}{\rho}\hat{a}_\rho + \frac{40}{\rho^2+4}\hat{a}_z$ A/m^2, then the total current crossing the plate $z = 0.2$ in the $\hat{a}_z$ direction, for ρ varying as $0 < \rho < 16$ is ________ A.

31. 524.57 (524.00 to 525.00)

$$I = \int \vec{J}\cdot\vec{ds} = \int_0^{16}\int_0^{2\pi} \frac{40}{\rho^2+4}\cdot\rho\, d\rho\, d\phi$$

Let

$$P = \rho^2 + 4$$

$$dP = 2\rho\, d\rho$$

$$\frac{dP}{2} = \rho\, d\rho$$

$$I = \frac{40\times 2\pi}{2}\cdot\int_4^{260}\left(\frac{dP}{P}\right)$$

$$I = 40\pi \ln\frac{260}{4} = 524.57\, A$$

Q.32 The electric field between two concentric cylindrical conductors at $r = 0.01$ m and $r = 0.05$ m is given by $\vec{E} = \left(\frac{10^5}{r}\right)\hat{a}_r$ V/m, fringing fields are neglected. If the energy stored in L m length is 0.244 J. Then L is ________ meters.

32. 0.50 (0.30 to 0.60)

$$W_E = \frac{1}{2}\int \epsilon_0\, E^2 dv$$

$$0.224 = \frac{\epsilon_0}{2}\int_h^{h+L}\int_0^{2\pi}\int_{0.01}^{0.05}\left(\frac{10^5}{r}\right)^2 r dr\, d\phi\, dz$$

$$0.224 = \frac{\epsilon_0}{2}\times L\times 2\pi\times\int_{0.01}^{0.05}\frac{10^{10}}{r}dr$$

$$L = \frac{0.224\times 2\times 10^{-10}}{\epsilon_0\times 2\pi\times \ln 5}$$

$$L = 0.5 \text{ m}$$

Q.33 The planes $z = 0$ and $z = 0.1$ m are perfect conductors. A voltage of 2V is maintained between them, such that $\vec{E}$ is in $\hat{a}_z$ direction. For $0 < z < 0.1$ m there is a conducting material for which $\sigma = 1000\ e^{-100\rho}$ s/m. The value of current density $\vec{J} =$ ________ $e^{-100\rho}\hat{a}_z$ A/m^2.

33. (20000)

Given planes $z = 0$ and $z = 0.1$ m are perfect conductors. A voltage difference of 2V is maintained such that $\vec{E} = |\vec{E}|\hat{a}_z$. A conducting material having $\sigma = 1000\ e^{-100\rho}$ s/m.

The electric field intensity,

$$\vec{E} = \frac{V}{d}\hat{a}_z = \frac{2}{0.1}\hat{a}_z$$

$$= 20\hat{a}_z \text{ V/m}$$

The current density,

$$\vec{J} = \sigma\vec{E}$$

$$= 1000e^{-100\rho} \times 20\hat{a}_z$$

$$= 20000e^{-100\rho}\hat{a}_z \text{ A/m}^2$$

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