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HW 1

1) The voltage between two parallel plates separated by a distance of 5 mm is 200 V. Determine the electric field intensity

$$E=\frac{V}{d}=\frac{200V}{5 x 10^{-3}m}=40000{V}/{m}$$

2) The Voltage between two parallel plates separated by a distance of 0.4 inch is 60 V. Determine the electric field intensity.

$$x=\frac{0.4 inch x 2.5cm}{inch}=1 cm=0.01 m$$

$$E=\frac{V}{d}= \frac{60 V}{1 x 10^{-2} m}=6000 {V}/{m}$$

3) The electric field intensity in the region between two parallel plates separated by a distance of 4 cm is 2 kV/m. Determine the voltage between the plates.

$$4 cm=0.04m$$

$$V=E x d=2000\frac{V}{m} \* 0.04 m=80 V$$

4) The electric field intensity in the region between two parallel plates separated by a distance of 8 mm is 200 V/mm. Determine the voltage between the plates.

$$V=E x d=200\frac{V}{mm} \* 8 mm=1600V$$

5) A direct current of 5 A is flowing in a conductor. Determine the magnetic field intensity at a distance of 3 m from the conductor.

$$H=\frac{I}{2πd}=\frac{5 A}{2\*π\*3 m}=265.26 mA/m$$

6) A direct current of 40 mA is flowing in a conductor. Determine the magnetic field intensity at a distance of 5 ft. from the conductor.

$$5ft=60 inches$$

$$x=\frac{60 inch x 2.5cm}{inch}=150 cm=1.5 m$$

$$H=\frac{I}{2πd}=\frac{40 mA}{2\*π\*1.5 m}=4.244 mA/m$$

7) For the parallel plates of Problem 3), determine the electric flux density if the dielectric is polyethylene ($\in \_{r}=2.25)$.

$$\in =\in \_{r}\*\in \_{0}=2.25\*8.842\*10^{-12}=19.89\*10^{-12} F/m$$

$$D=\in \*E=19.89\*10^{-12}\frac{F}{m}\* 2000\frac{V}{m}=39.78 nC/m^{2}$$

8) For the parallel plates of Problem 4), determine the electric flux density if the dielectric is air.

$$\in =\in \_{0}=8.842\*10^{-12} F/m$$

$$D=\in \*E=8.842\*10^{-12}\frac{F}{m}\* 200\frac{V}{mm}=1.768 nC/mm^{2}$$

9) For the current-carrying conductor of Problem 5), determine the magnetic flux density at a distance of 3 m from the conductor if the medium is air.

$$μ=μ\_{0}=4π\*10^{-7}=1.2566\*10^{-6} H/m$$

$$B=μ\*H=1.2566\*10^{-6}\frac{H}{m}\* 265.26\frac{mA}{m}=333.32 nWb/m^{2}$$

10) For the current-carrying conductor of Problem 6), determine the magnetic flux density at a distance of 5 ft from the conductor if the medium is air.

$$μ=μ\_{0}=4π\*10^{-7}=1.2566\*10^{-6} H/m$$

$$B=μ\*H=1.2566\*10^{-6}\frac{H}{m}\* 4.244\frac{mA}{m}=5.333 nWb/m^{2}$$

11) The electric flux density normal to a rectangular surface with dimensions 8 m x 75 cm is 4 $μC/m^{2}$. Determine the value of the electric flux across the area.

$$A=8m\*0.75m=6 m^{2}$$

$$ψ=A\*D=6 m^{2}\*4\frac{μC}{m^{2}}=24 μC$$

12) The electric flux density normal to a circular surface with a diameter of 3m is 8 $μC/m^{2}$. Determine the value of the electric flux across the area.

$$A=πr^{2}=\left(π\right)\*1.5^{2}=7.06 m^{2}$$

$$ψ=A\*D=7.06 m^{2}\*8\frac{μC}{m^{2}}=56.55 μC$$

13) The magnetic flux density normal to a circular surface with a radius of 5m is 4$ nWb/m^{2}$. Determine the value of the magnetic flux across the area.

$$A=πr^{2}=\left(π\right)\*5^{2}=78.539 m^{2}$$

$$ϕ=A\*B=78.539 m^{2}\*4\frac{nWb}{m^{2}}=314.159 nWb$$

14) The magnetic flux density normal to a rectangular surface with dimensions 30 cm x 60 cm is 12$ nWb/m^{2}$. Determine the value of the magnetic flux across the area.

$$A=0.30m\*0.60m=0.18 m^{2}$$

$$ϕ=A\*B=0.18 m^{2}\*12\frac{nWb}{m^{2}}=2.16 nWb$$

15) A current of 8 A is uniformly distributed over a rectangular conductor with dimensions 5 mm x 4 mm. Determine the current density.

$$A=0.005m\*0.004m=0.00002 m^{2}$$

$$J=\frac{I}{A}=\frac{8 A}{0.00002 m^{2}}=400000 \frac{A}{m^{2}}$$

16) A current of 4 A is uniformly distributed over a circular conductor with a dimensions 3 cm. Determine the current density.

$$A=πr^{2}=\left(π\right)\*\left(0.015^{2}\right)=706.85\*10^{-6} m^{2}$$

$$J=\frac{I}{A}=\frac{4 A}{706.86\*10^{-6} m^{2}}=5.658 \frac{kA}{m^{2}}$$

17) Assume that the conductivity for the conductor of Problem 15) is 5 MS/m. Determine the electric field intensity.

$$E=\frac{J}{σ}=\frac{400000 {A}/{m^{2}}}{5 MS/m}=80 {mV}/{m}$$

18) Assume that the conductivity for the conductor of Problem 16) is $6 x 10^{7}$ S/m. Determine the electric field intensity.

$$E=\frac{J}{σ}=\frac{5.658 {kA}/{m^{2}}}{6\*10^{7} S/m}=94.3 μ{V}/{m}$$

19) The rms magnitude of the magnetic field of a plane wave in air is $H\_{y}=200 {μA}/{m}$. Assuming that E is in the positive x-direction, determine the following for a circular surface of diameter 50 m in the x-y plane over which the fields are constant:

(a)$E\_{x}$

$$η\_{0}=120π=377Ω$$

$$E\_{x}=ηH\_{y}=377 Ω\*200\frac{μA}{m}=75.4 mV/m$$

(b)$P\_{z}$

$$P\_{z}=\frac{E\_{x}^{2}}{n\_{0}}=\frac{75.4 ^{2}mV/m}{377}=15.08 μW/m^{2}$$

(c) Total power transmitted through area

$$A=π\*r^{2}=π\*25^{2}=1.963\*10^{3} m^{2}$$

$$P=P\_{z}\*A=15.08\frac{μW}{m^{2}}\*1.963\*10^{3} m^{2}=29.61 mW$$

20) The rms magnitude of the magnetic field of a plane wave in sea water ($\in \_{r}=80)$ is $E\_{x}=3 V/m$. Assuming that H is in the positive y-direction, determine the following for a square surface with sides of 15 m each in the x-y plane over which the fields are constant:

(a)$H\_{y}$

$$η=\frac{η\_{0}}{\sqrt{\in \_{r}}}=\frac{377}{\sqrt{80}}=42.15Ω$$

$$H\_{y}=\frac{E\_{x}}{η\_{0}}=\frac{3 V/m}{42.15Ω}=71.17 mA/m$$

(b)$P\_{z}$

$$P\_{z}=\frac{E\_{x}^{2}}{n\_{0}}=\frac{3^{2} V/m}{71.17 mA/m}=126.46 W/m^{2}$$

(c) Total power transmitted through area

$$A=15m\*15m=225 m$$

$$P=P\_{z}\*A=126.46\frac{W}{m^{2}}\*225 m=28.45 kW$$

21) In a lossless dielectric medium, the rms electric and magnetic field intensities are $E\_{x}=50 mV/m$ and $H\_{y}=100 μA/m$. Determine the following:

(a) Intrinsic impedance

$$η=\frac{E\_{x}}{H\_{y}}=\frac{50 mV/m}{100 μA/m}=500Ω$$

(b) Power density

$$P\_{z}=E\_{x}\*H\_{y}=50\frac{mV}{m}\*100\frac{μA}{m}=5 μW/m^{2}$$

(c) Dielectric constant

$$η=\frac{η\_{0}}{\sqrt{\in \_{r}}}=\frac{377}{\sqrt{\in \_{r}}}$$

$$\in \_{r}=\frac{377^{2}}{η^{2}}=\frac{377^{2}}{500Ω^{2}}=568.51\*10^{-3}$$