Unit - 5 Tutorial Solution

1. $H_c(T) = H_c(0)\left\{1-\left(\frac{T}{T_c}\right)^2\right\}$

Here, $H_c(T) = 105\times10^3$ A/m, $T_c = 9.3$K, $H_c(0) = 150\times10^3$ A/m

$$\frac{H_c(T)}{H_c(0)} = 1-\left(\frac{T}{T_c}\right)^2 \Rightarrow T = T_c\left\{1-\frac{H_c(T)}{H_c(0)}\right\}^{1/2}$$

$$\boxed{T = 5.03\text{K}.}$$

2. $H_c(T) = H_c(0)\left\{1-\left(\frac{T}{T_c}\right)^2\right\}$

Here, $T = 14$ K, $H_c(T) = 0.176$ T

and at $T = 13$K, $H_c(T) = 0.528$ T

$$\therefore\ 0.176 = H_c(0)\left\{1-\left(\frac{14}{T_c}\right)^2\right\} \quad -(1)$$

$$0.528 = H_c(0)\left\{1-\left(\frac{13}{T_c}\right)^2\right\} \quad -(2)$$

(2)/(1)

$$\frac{0.528}{0.176} = \frac{1-(13/T_c)^2}{1-(14/T_c)^2}$$

$$\boxed{T_c = 14.5\text{K}}$$

from eq^n (1)

$$H_c(0) = \frac{0.176}{1-\left(\frac{14}{T_c}\right)^2} = \frac{0.176}{1-\left(\frac{14}{14.5}\right)^2} = \boxed{2.588\text{T} = H_c(0)}$$

at $T = 4.2$K $\rightarrow H_c(T) = H_c(0)\left\{1-\left(\frac{4.2}{14.5}\right)^2\right\}$

$$\boxed{H_c(T) = 2.37\text{T}}$$

3. $H_c(T) = H_c(0)\left\{1-\left(\frac{T}{T_c}\right)^2\right\}$

$T_c = 7.2$K, $T = 5$K, $H_c(T) = 3.3\times10^4$ A/m

$$\therefore H_c(0) = \frac{3.3\times10^4}{1-(5/7.2)^2} = \boxed{6.37\times10^4\text{ A/m} = H_c(0)}$$

4. $H_c(T) = H_c(0)\left\{1-\left(\frac{T}{T_c}\right)^2\right\}$

here, $T = 14.1K$, $H_c(T) = 1.41\times10^5$ A/m

at $T = 12.9K$, $H_c(T) = 4.205\times10^5$ A/m

$\therefore 4.205\times10^5 = H_c(0)\times\left\{1-\left(\frac{12.9}{T_c}\right)^2\right\}$ — (1)

$1.41\times10^5 = H_c(0)\left\{1-\left(\frac{14.1}{T_c}\right)^2\right\}$ — (2)

(1)/(2)

$$\frac{4.205\times10^5}{1.41\times10^5} = \frac{1-(12.9/T_c)^2}{1-(14.1/T_c)^2} \Rightarrow \boxed{T_c = 14.67K}$$

from eq^n (1)

$$H_c(0) = \frac{4.205\times10^5}{1-\left(\frac{12.9}{14.67}\right)^2} = 18.455\times10^5 \text{ A/m}$$

at $T = 4.2K$, $H_c(T) = 18.455\times10^5\left\{1-\left(\frac{4.2}{14.67}\right)^2\right\}$

$$\boxed{H_c(T) = 17.21\times10^5 \text{ A/m.}}$$

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5. $H_c(T) = H_c(0)\left\{1-\left(\frac{T}{T_c}\right)^2\right\}$

here, $H_c(0) = 6.5\times10^3$ A/m, $H_c(T) = 4.5\times10^3$ A/m, $T_c = 7.18K$

$$\therefore 1-\left(\frac{T}{T_c}\right)^2 = \frac{H_c(T)}{H_c(0)} \Rightarrow T = T_c\left\{1-\frac{H_c(T)}{H_c(0)}\right\}^{1/2}$$

On solving, $\boxed{T = 3.98K}$

$\rightarrow I_c = 2\pi r H_c$; $r = \frac{D}{2} = 1mm = 10^{-3}m$

critical current density, $J_c = \frac{I_c}{\pi r^2} = \frac{2\pi r H_c(T)}{\pi r^2}$

$$\boxed{J_c = 9.0\times10^6 \text{ A/m}^2}$$

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6. $I_c = 2\pi r H_c$

here, $r = \frac{D}{2} = \frac{10^{-3}m}{2}$; $H_c = 7.9\times10^3$ A/m

$\therefore I_c = 2\times3.14\times\frac{10^{-3}}{2}\times7.9\times10^3 = \boxed{24.81 \text{ Amp.} = I_c}$

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7. $I_c = 2\pi r H_c$, here, $r = \frac{D}{2} = 10^{-3}m$, $H_c = 1.21\times10^4$ A/m

$I_c = 2\times3.14\times10^{-3}\times1.21\times10^4 = \boxed{75.98 \text{ Amp} = I_c}$

$J_c = \frac{I_c}{\pi r^2} = \frac{75.98}{3.14\times(10^{-3})^2} = \boxed{2.42\times10^6 \text{ A/m}^2 = J_c}$