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Chapter **30** (Benson)

E01 $F = \mu_0 I_1 I_2 bc/2\pi a(a+b)$.

E06 $F = \mu_0 I_1 I_2/2\pi d$: $F_{38} = 80\,(\mu\text{N/m})$, $F_{36} = 60\,(\mu\text{N/m})$. $F_x = (F_{38} + F_{36})\cos 60^0 = 70\,(\mu\text{N/m})$; $F_y = (F_{38} - F_{36})\sin 60^0 = 17.3\,(\mu\text{N/m})$.

E09 $B = (\mu_0 I/2a)/2 + 2(\mu_0 I/4\pi a) = (\mu_0 I/2a)(1/2 + 1/\pi)$, out .

E10 $B = \mu_0 I/2a + \mu_0 I/2\pi a = (\mu_0 I/2a)(1 + 1/\pi)$, out of page .

E11 $B = \mu_0 I/4a - \mu_0 I/4b = (\mu_0 I/4)(1/a - 1/b)$, into page .

E22 $B_{cir} = \mu_0 I/4a$, $B_h = (\mu_0 I/8\pi a)(2\sin\alpha_1)$, $B_v = 2(\mu_0 I/4\pi a)(\sin\alpha_2)$, where $\sin\alpha_1 = 1/\sqrt{5}$, $\sin\alpha_2 = 2/\sqrt{5}$. $B = (\mu_0 I/a)(1/4 + 1/\pi\sqrt{5} + 1/4\pi\sqrt{5})$.

E23 (**a**) $B = (\mu_0 I/4)(1/a + 1/b) = 3.14\times 10^{-5}$ T;

(**b**) $\mu = IA = I\pi(a^2 + b^2) = 0.254\,\text{A}\cdot\text{m}^2$.

E27 $\oint \vec{B}\cdot d\vec{l}$ is not zero, even though $I = 0$.

E32 $\vec{B}$ is normal to $d\vec{l}$ for the radial sections. For circular arcs:

$\int \vec{B}\cdot d\vec{l} = (\mu_0 I/2\pi a)(\pi a/2) + (\mu_0 I/2\pi b)(3\pi b/2) = \mu_0 I$.

E42 $F_{12} = \mu_0 I_1 I_2/2\pi r$. $F_x = \mu_0 I^2/2\pi d - \mu_0 I^2\cos 45^0/2\pi\sqrt{2}d = \mu_0 I^2/4\pi d$, $F_y = -\mu_0 I^2/2\pi d - \mu_0 I^2\cos 45^0/2\pi\sqrt{2}d = -3\mu_0 I^2/4\pi d$. With $d = 5$ cm & $I = 8$ A, $\vec{F} = (1.28\,\hat{\imath} - 3.84\,\hat{\jmath})\times 10^{-4}$ N/m .

P01 $I = q/T = qv/2\pi R$; $mv^2/R = qvB$, or $v = qRB/m$; Thus $I = q^2B/2\pi m$ $B = \mu_0 I/2a = \mu_0 q^2 B/4\pi m R$. (Teacher: Jyh-Shinn Yang, 89.06.03)

P02 (**a**) $B = (\mu_0 NIR^2/2)\big([R^2 + (R/2 + x)^2]^{-3/2} + [R^2 + (R/2 - x)^2]^{-3/2}\big)$;

(**b**) As $x = 0$, $B = \mu_0 NI(4/5)^{3/2}$.

P09 The field due to an infinite cylinder inside it is $\vec{B} = \mu_0 I\vec{r}/2\pi R^2$, where $\vec{r}$ is position vector from the axis. For a long, solid wire containing a cavity of radius a can be treated as the superposition of a completely solid wire and a wire of radius a carrying a current in the opposite direction. Therefore, the field in the cavity is $\vec{B} = (\mu_0 I/2\pi R^2)(\vec{r}_1 - \vec{r}_2)$, where $\vec{r}_1$ and $\vec{r}_2$ are the position vectors from the axes of the solid wires with radia R and a, respectively. Thus $\vec{B} = (\mu_0 I/2\pi R^2)\vec{d}$, uniform in the cavity .