3-1. (1) $R = \frac{U}{I} = 0.029\,\Omega$

(2) $\rho = \frac{RS}{L} = \cancel{7.28\times10^{-8}\,\Omega\cdot m}\ \frac{R\cdot\pi\cdot\frac{d^2}{4}}{L} = 1.84\times10^{-8}\,\Omega\cdot m$

(3) $\because jS = I$

$j = \frac{I}{S} = \frac{I}{\pi\cdot\frac{d^2}{4}} = 2.39\times10^{-5}\,A/m^2$

(4) $j = \sigma E$

$E = \rho j = 4.4\times10^{-3}\,V/m$

(5) $j = nqv$

$n = \frac{j}{qv} = 8.79\times10^{28}\,m^{-3}$

3-2. (1) 左段导线延长线过O点. $\cancel{I_1}$ $B_1 = 0$.

$B_2 = \int_L \frac{Idl\cdot\mu_0}{a^2\cdot4\pi} = \frac{\mu_0 I}{4\pi a}$

$\therefore B = B_2 = \frac{\mu_0 I}{4\pi a}$ 方向朝外

(2) 两段直导线 $B_1 = 2\cdot\frac{\mu_0 I}{4\pi r} = \frac{\mu_0 I}{2\pi r}$

$B_2 = \int \frac{Idl\cdot\mu_0}{r^2\cdot4\pi} = \frac{\mu_0 I}{4r}$

$\therefore B = \frac{\mu_0 I(2+\pi)}{4\pi r}$ 方向朝内

3-4. O点位于导线延长线 $B_1 = B_2 = 0$

$B_{a\to b内} = \int_{ab内} \frac{Idl\cdot\mu_0}{r^2\cdot4\pi} = \frac{I_1\mu_0}{4\pi r^2}\cdot l_内$ 方向朝外

$B_{a\to b外} = \frac{I_2\mu_0}{4\pi r^2} l_外$ 方向朝内

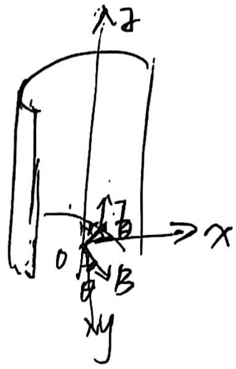
$\because I_1R_1 = I_2R_2$ $\because R_1 = \rho\frac{l_内}{S}$ $R_2 = \rho\frac{l_外}{S}$

$\therefore I_1 l_内 = I_2 l_外$ $\therefore B_{a\to b内} = B_{a\to b外}$

$\because B_内$与$B_外$方向相反

$\therefore B_总 = 0$.

3-6. $\cancel{B = \int_0^{\pi R} \frac{\frac{I}{\pi R}\mu_0 dl}{2\pi R} = \frac{\mu_0 I}{2\pi R}}$



由对称性. $B_z = B_y = 0$.

故 $B = B_x$

$$B_x = 2\int_0^{\frac{\pi}{2}} \frac{\frac{I}{\pi R}\cdot R\,d\theta\cdot\mu_0}{2\pi R}\cdot\sin\theta$$

$$= \frac{\mu_0 I}{\pi^2 R}\int_0^{\frac{\pi}{2}} \sin\theta\, d\theta$$

$$= \frac{\mu_0 I}{\pi^2 R}(-\cos\theta)\Big|_0^{\frac{\pi}{2}}$$

$$= \frac{\mu_0 I}{\pi^2 R}$$ 方向沿 x 轴正方向

3-9. ∵ $dQ = \sigma\theta r dr$

$dI = \frac{\sigma\theta dr}{T} = \frac{\omega\sigma\theta}{2\pi}dr$

∴ $dB = \frac{\mu_0 dI}{2r}$

$B = \int_0^R \frac{\mu_0 dI}{2r} = \int_0^R \frac{\mu_0\omega\sigma\theta}{4\pi r}dr = \frac{\mu_0\omega\sigma\theta R}{4\pi}$ 方向垂直纸面向外

3-10. (1) $r<R_1$. $B\cdot 2\pi r = \frac{\pi r^2}{\pi R_1^2}\mu_0 I$

$B = \frac{\mu_0 r I}{2\pi R_1^2}$　　由对称性, B沿圆环相等

方向与I满足右手螺旋. 逆时针

(2) $R_1<r<R_2$　$B = \frac{\mu_0 I}{2\pi r}$　方向同(1)

(3) $R_2<r<R_3$　$B\cdot 2\pi r = \mu_0 I - \frac{\pi r^2 - \pi R_2^2}{\pi R_3^2 - \pi R_2^2}\mu_0 I = \frac{\pi R_3^2 - \pi r^2}{\pi R_3^2 - \pi R_2^2}\mu_0 I$

$B = \frac{R_3^2 - r^2}{(2\pi r)(R_3^2 - R_2^2)}\mu_0 I$

方向同(1)

(4) $B=0$.

3-11. ∵ 挖去前. 圆柱对轴线处 $B=0$. 对O处 ~~$B_0 = \frac{\mu_0 I}{2\pi d}\pi$~~

挖去的圆柱对轴线O $B_0 = \frac{\mu_0 I}{2\pi d}\cdot\frac{\pi r^2}{\pi R^2 - \pi r^2} = \frac{\mu_0 I r^2}{2\pi d(R^2-r^2)}$

∴ 挖去后O处 $B_0 = -\frac{\mu_0 I r^2}{2\pi d(R^2-r^2)}$

同理. 不挖去时 $B_{0'} = \frac{\mu_0 I}{2\pi d}\cdot\frac{d^2}{R^2-r^2} = \frac{\mu_0 I d}{2\pi(R^2-r^2)}$

∵ 挖去圆柱对轴心O'处 $B=0$

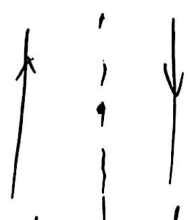
∴ 挖去后 $B_{0'} = \frac{\mu_0 I d}{2\pi(R^2-r^2)}$. 方向与I满足右手螺旋

B_0 方向与 $B_{0'}$ 相反

3-12. (1) 一根直导线. 对等距处 $B_0 = \frac{\mu_0 I}{2\pi\cdot\frac{d}{2}} = \frac{\mu_0 I}{\pi d}$

∵ 两导线在等距处产生B方向一致

∴ $B = 2B_0 = \frac{2\mu_0 I}{\pi d} = 4\times10^{-5}T$ 方向垂直纸面向外



~~(2) ∵ $B_1 = \frac{\mu_0 I}{2\pi(r_1+r)}$　$B_2 = \frac{\mu_0 I}{2\pi(d-r_1-r)}$　$B = \frac{\mu_0 I}{2\pi}\left(\frac{1}{r_1+r}+\frac{1}{d-r_1-r}\right)$~~

~~∴ $B = \int_0^{r_2} B dr = \frac{\mu_0 I}{2\pi}(\ln(r_1+r_2) - \ln r_1 - \ln(d-r_1-r_2) + \ln(d-r_1)) = 0$~~

(2) $\because B = \frac{d\Phi}{dS}$

$\therefore \Phi = \int_S B\,dS = 2\int_0^{r_2} \frac{\mu_0 I}{2\pi(r_1+r)} l\,dr = \frac{\mu_0 I l}{\pi} \ln \frac{r_1+r_2}{r_1}$

$= 2.2 \times 10^{-6}\,Wb.$