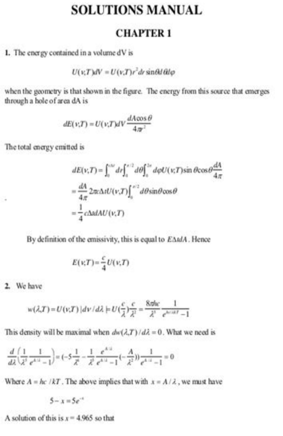

SOLUTIONS MANUAL

CHAPTER 1

1. The energy contained in a volume dV is

$$U(\nu,T)dV = U(\nu,T)r^2 dr \sin\theta d\theta d\varphi$$

when the geometry is that shown in the figure. The energy from this source that emerges through a hole of area dA is

$$dE(\nu,T) = U(\nu,T)dV \frac{dA\cos\theta}{4\pi r^2}$$

The total energy emitted is

$$dE(\nu,T) = \int_0^{c\Delta t} dr \int_0^{\pi/2} d\theta \int_0^{2\pi} d\varphi U(\nu,T)\sin\theta\cos\theta \frac{dA}{4\pi}$$
$$= \frac{dA}{4\pi} 2\pi c\Delta t U(\nu,T) \int_0^{\pi/2} d\theta \sin\theta\cos\theta$$
$$= \frac{1}{4} c\Delta t dA U(\nu,T)$$

By definition of the emissivity, this is equal to $E\Delta t dA$. Hence

$$E(\nu,T) = \frac{c}{4} U(\nu,T)$$

2. We have

$$w(\lambda,T) = U(\nu,T)\,|d\nu/d\lambda| = U(\frac{c}{\lambda})\frac{c}{\lambda^2} = \frac{8\pi hc}{\lambda^5}\frac{1}{e^{hc/\lambda kT}-1}$$

This density will be maximal when $dw(\lambda,T)/d\lambda = 0$. What we need is

$$\frac{d}{d\lambda}\left(\frac{1}{\lambda^5}\frac{1}{e^{A/\lambda}-1}\right) = (-5\frac{1}{\lambda^6} - \frac{1}{\lambda^5}\frac{e^{A/\lambda}}{e^{A/\lambda}-1}(-\frac{A}{\lambda^2}))\frac{1}{e^{A/\lambda}-1} = 0$$

Where $A = hc/kT$. The above implies that with $x = A/\lambda$, we must have

$$5 - x = 5e^{-x}$$

A solution of this is $x = 4.965$ so that