HW 4 Dominic Riccoboni

Table of Contents

Radiation Constants

```
h = 6.62607015e-34; %[Js] Planck's constant
KB = 1.380649e-23; %[J/K] Boltzmann constant
C0 = 2.9979e8; %[m/s] Speed of light in vacuum
C1 = h*C0^2 %[Jm^2/s];
```

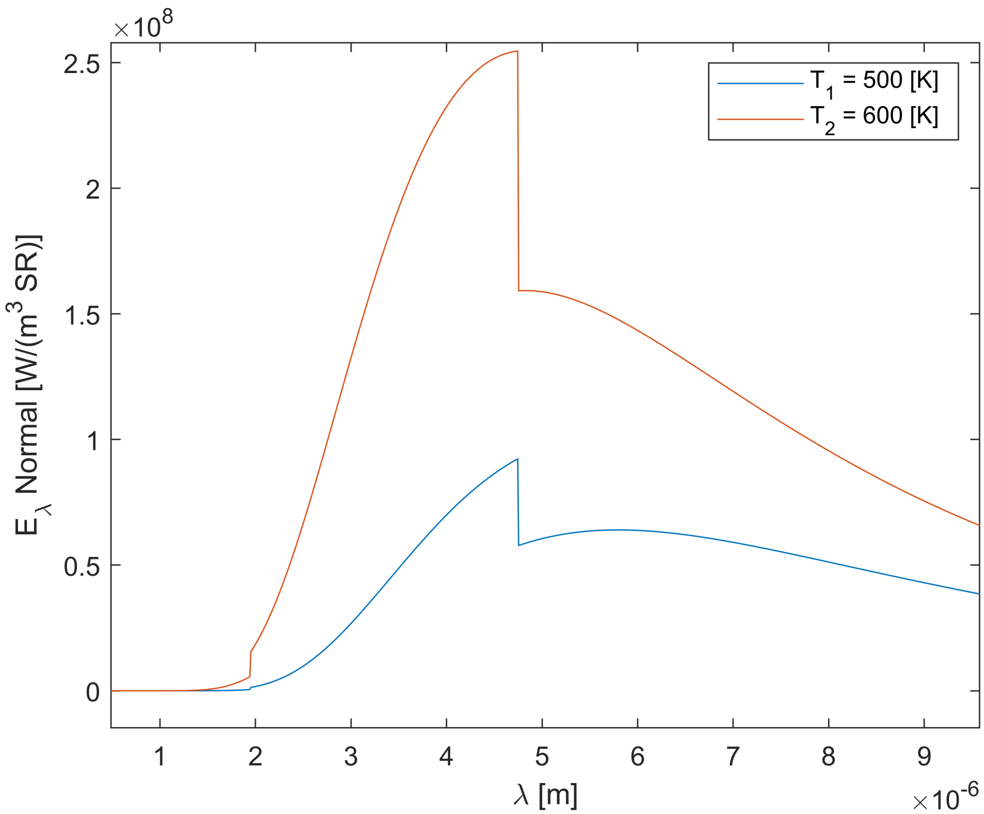
```
C1 = 5.9551e-17
```

```
C2 = h*C0/KB; %[m*K]
sigma = 2*C1*pi^5/(15*C2^4);
```

Problem 2.4

```
E_lam_b_fun = @(lambda,T) 2*C1./lambda.^5./(exp(C2./(lambda.*T))-1); %Function handle
% for normal spectral emissive power

n = 1000; %Number of points to plot

lambdas = linspace(0, 10e-6, n); %Domain variable is wavelength

T1 = 500; %500 [K]
T2 = 600; %600 [K]

E_lam_b1 = E_lam_b_fun(lambdas,T1*ones(size(lambdas))); %Evaluate E_lam_b_fun
% at lambdas and T1
E_lam_b2 = E_lam_b_fun(lambdas,T2*ones(size(lambdas))); %Evaluate E_lam_b_fun
% at lambdas and T2

%Creat piecewise emissivity data
i_lambda1 = lambdas <= 1.95e-6;
i_lambda2 = (1.95e-6 < lambdas) & (lambdas <= 4.75e-6);
i_lambda3 = 4.75e-6 < lambdas;
emsvty_lam = [0.3*ones(size(lambdas(i_lambda1))),...
    0.8*ones(size(lambdas(i_lambda2))), 0.5*ones(size(lambdas(i_lambda3)))];

%Plot results
figure
plot(lambdas, emsvty_lam.*E_lam_b1,lambdas, emsvty_lam.*E_lam_b2)
xlabel('\lambda [m]')
```

```
ylabel('E_{\lambda} Normal [W/(m^3 SR)]')
legend('T_1 = 500 [K]','T_2 = 600 [K]')

xlim([0.00000000 0.00001000])
ylim([-20991254 279008746])

xlim([0.00000049 0.00000958])
ylim([-14789293 257937980])
```




```
%Get lambdas at max emissive power
[E_lam_b1_max, i1] = max(emsvty_lam.*E_lam_b1);

lambda_max1 = lambdas(i1)
```

```
lambda_max1 = 4.7447e-06
```

```
[E_lam_b2_max, i2] = max(emsvty_lam.*E_lam_b2);

lambda_max2 = lambdas(i2)
```

```
lambda_max2 = 4.7447e-06
```

Problem 2.5

Total emissivity at 300 [K]

```
T1 = 300;
```

```
%Spectral emissivitys
e1 = 0.83;
e2 = 0.5;
e3 = 0.17;

%cutoff lambdas (piecewise emissivity)
lam1 = 1.9e-6;
lam2 = 2.8e-6;

%Integrand function handles
Integrand1 = @(lambda) e1*2*pi*C1./lambda.^5./(exp(C2./(lambda*T1))-1);
Integrand2 = @(lambda) e2*2*pi*C1./lambda.^5./(exp(C2./(lambda*T1))-1);
Integrand3 = @(lambda) e3*2*pi*C1./lambda.^5./(exp(C2./(lambda*T1))-1);

%Numerical integration
Total_emsvty = (integral(Integrand1, 0,lam1) + integral(Integrand2, lam1, lam2)...
    + integral(Integrand3, lam2, 1))/(sigma*T1^4)
```

```
Total_emsvty = 0.1700
```

Total absorptivity at 5780 [K]

```
T2 = 5780;

%Spectral emissivitys
e1 = 0.83;
e2 = 0.5;
e3 = 0.17;

%cutoff lambdas (piecewise emissivity)
lam1 = 1.9e-6;
lam2 = 2.8e-6;

%Integrand function handles
Integrand1 = @(lambda) e1*2*pi*C1./lambda.^5./(exp(C2./(lambda*T2))-1);
Integrand2 = @(lambda) e2*2*pi*C1./lambda.^5./(exp(C2./(lambda*T2))-1);
Integrand3 = @(lambda) e3*2*pi*C1./lambda.^5./(exp(C2./(lambda*T2))-1);

%Numerical integration
Total_abstvty = (integral(Integrand1, 0,lam1) + integral(Integrand2, lam1, lam2)...
    + integral(Integrand3, lam2, 1))/(sigma*T2^4)
```

```
Total_abstvty = 0.7990
```

Problem 2.10

part a

```
T1 = 750;

lambdas = [0.0001 1 1.5 2 2.5 3 3.5 4 4.5 5 6 7 8 100000]*10^-6;
emsvtys = [0 0 0.2 0.4 0.6 0.8 0.8 0.8 0.7 0.6 0.4 0.2 0 0];
E_lam_bs = 2*pi*C1./lambdas.^5./(exp(C2./(lambdas*T1))-1);
```

```
Total_emsvty_a = trapz(lambdas,emsvtys.*E_lam_bs)/(sigma*T1^4)
```

```
Total_emsvty_a = 0.4168
```

part b

```
T2 = 1600;

lambdas = [0.0001 1 1.5 2 2.5 3 3.5 4 4.5 5 6 7 8 100000]*10^-6;
emsvtys = [0 0 0.2 0.4 0.6 0.8 0.8 0.8 0.7 0.6 0.4 0.2 0 0];
E_lam_bs = 2*pi*C1./lambdas.^5./(exp(C2./(lambdas*T2))-1);

Total_emsvty_b = trapz(lambdas,emsvtys.*E_lam_bs)/(sigma*T2^4)
```

```
Total_emsvty_b = 0.4666
```

Problem 2.20

```
P.h = h; %[Js] Planck's constant
P.KB = KB; %[J/K] Boltzmann constant
P.C0 = C0; %[m/s] Speed of light in vacuum
P.C1 = C1; %[Jm^2/s];
P.C2 = C2; %[m*K]
P.sigma = sigma; %Plank's constant

P.rho = 3200; %Density of the plate [kg/m^3]
P.C = 710; % Specific heat of the plate material [J/kgK]
P.l = .0025; %Thickness of the plate [m]

p_2_20_EOM_hand = @(t,T)p_2_20_EOM(t,T,P);

T0 = 1400; %[K] Initial plate temperature

[tout, Tout] = ode45(p_2_20_EOM_hand, [0, 20.5*60], T0);

tfinal = tout(end)
```

```
tfinal = 1230
```

```
Tfinal = Tout(end)
```

```
Tfinal = 350.1861
```

```
function Tdot = p_2_20_EOM(t,T,P)


    lam1 = 10^-6;
    lam2 = 10^-5;
    lam3 = 100;

    %Integrand function handles
    Integrand1 = @(lambda) (94444*lambda - 0.094444)...
        *2*P.C1./lambda.^5./(exp(P.C2./(lambda*T))-1);
    Integrand2 = @(lambda) (0.85)*2*P.C1./lambda.^5./(exp(P.C2./(lambda*T))-1);
```

```
    %Numerical integration
    intgrl = integral(Integrand1, lam1,lam2) + integral(Integrand2, lam2, lam3);

    Tdot = -1/(P.rho*P.C*P.l)*pi*intgrl;

end
```