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```
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%  ASEN 3113 Homework 10
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%  Date: 27 April, 2022
%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%


clear
close all;
clc
```

Helpful Functions / Constants

Constants

```
sigma = 5.67e-08;
g = 9.81; %[m/s^2]
```

Grashof Number

```
Gr = @(g,beta,T_s,T_inf,L_c,v) (g*beta*(T_s-T_inf)*L_c^3)/v^2;
```

Nusselt Vertical Plate

```
Nu_VP = @(Ra,Pr) (0.825 + (0.387*Ra^(1/6)) / (1 + (0.492/
Pr)^(9/16))^(8/27))^2;
```

Problem 20-16

Given

```
L = 0.2; %[m]
t = 25e-03; %[m]
k_p = 15; %[W/mK]
T_s_h = 100 + 273; %[K]
T_c = 7 + 273; %[K]
T_guess = 12.5 + 273; %[K]

% Sourced from internet because the textbook wasn't helpful
v = 1e-03^2; %[m^2/s]
beta = 210e-06; %[1/K]
alpha = 1.4558e-07; %[m^2/s]
```

Solve for Grashof Number

```
Gr_1 = Gr(g,beta,T_guess,T_c,L,v);
```

Solve for Prandtl Number

```
Pr_1 = v/alpha;
```

Solve for Rayleigh Number

```
Ra_1 = Gr_1 * Pr_1;
```

Solve for Nusselt Number

```
Nu_1 = Nu_VP(Ra_1,Pr_1);
```

Compare to Condunction Heat Transfer

```
h = Nu_1 * k_p / L;

q_conv = h*(T_guess - T_c);

q_cond = k_p/t*(T_s_h - T_guess);

% After iterating between a couple different values, the final
% temperature settled on was as follows:
fprintf('Problem 20-16: \n \n')
```

```
fprintf('T_s [deg C]: \n')
disp(T_guess-273)
```

```
Problem 20-16:

T_s [deg C]:
   12.5000
```

Problem 20-30

Given

```
A_pcb = 0.15 * 0.20; %[m^2]
T_inf = 20; %[deg C]
Q_dis = 8; %[W]
epsilon = 0.8;
```

Properties of Surrounding Air (Table A-22)

Here we are going to take an initial guess that T_s = 45 [deg C] T_av = 32.5 [deg C]

```
T_s = 45;
T_av = (T_s + T_inf) / 2;
k = 0.0265; %[W/mK]
v = 1.62e-05; %[m^2/s]
Pr = 0.711;
beta = 1/(T_av + 273); %[1/K]
```

Part a)

```
% Guessing Value
T_guess = 46.315;

% Calculate Grashof Number
Gr_ = Gr(g,beta,T_guess,T_inf,0.2,v);

% Calculate Rayleigh Number
Ra = Gr_ * Pr;

% Calculate Nusselt Number
Nu_ = Nu_VP(Ra,Pr);

% Find convection heat coefficient
h = Nu_ * k / 0.2; %[W/m^2K]

% Heat Balance Equation (with radiation)
%
% Q_dis = Q_conv + Q_rad

Q_trans_a = h*A_pcb*(T_guess - T_inf) +
epsilon*sigma*A_pcb*((T_guess+273)^4 - (T_inf+273)^4);
```

```
% After iterating across a couple of guesses to get the surface
% temperature such that the heat leaving through convection and
% radiation would be equal to the power dissapation, the resulting
% surface temperature was:
fprintf('Problem 2: \n \n')
fprintf('Part a) \n')
fprintf('Surface Temperature [deg C]: \n')
disp(T_guess)
```

```
Problem 2:

Part a)
Surface Temperature [deg C]:
   46.3150
```

Part b)

```
% New Temperature Guess
T_guess = 41.8; %[deg C]

% Characteristic Length
L_c = A_pcb / (2*0.15 + 2*0.2);

% Grashof Number
Gr_ = Gr(g,beta,T_guess,T_inf,L_c,v);

% Rayleigh Number
Ra_ = Gr_ * Pr;

% Nusselt Number
Nu_ = 0.59*Ra_^0.25;

% Find convection heat coefficient
h = Nu_ * k / L_c; %[W/m^2K]

% Heat Balance Equation (with radiation)
%
% Q_dis = Q_conv + Q_rad

Q_trans_b = h*A_pcb*(T_guess - T_inf) +
 epsilon*sigma*A_pcb*((T_guess+273)^4 - (T_inf+273)^4);

% After iterating across a couple of guesses to get the surface
% temperature such that the heat leaving through convection and
% radiation would be equal to the power dissapation, the resulting
% surface temperature was:
fprintf('Part b) \n')
fprintf('Surface Temperature [deg C]: \n')
disp(T_guess)
```

```
Part b)
Surface Temperature [deg C]:
```

```
   41.8000
```

Part c)

```
% New Temperature Guess
T_guess = 50.1; %[deg C]

% Characteristic Length
L_c = A_pcb / (2*0.15 + 2*0.2);

% Grashof Number
Gr_ = Gr(g,beta,T_guess,T_inf,L_c,v);

% Rayleigh Number
Ra_ = Gr_ * Pr;

% Nusselt Number
Nu_ = 0.27*Ra_^0.25;

% Find convection heat coefficient
h = Nu_ * k / L_c; %[W/m^2K]

% Heat Balance Equation (with radiation)
%
% Q_dis = Q_conv + Q_rad

Q_trans_c = h*A_pcb*(T_guess - T_inf) +
 epsilon*sigma*A_pcb*((T_guess+273)^4 - (T_inf+273)^4);

% After iterating across a couple of guesses to get the surface
% temperature such that the heat leaving through convection and
% radiation would be equal to the power dissapation, the resulting
% surface temperature was:
fprintf('Part c) \n')
fprintf('Surface Temperature [deg C]: \n')
disp(T_guess)
```

```
Part c)
Surface Temperature [deg C]:
   50.1000
```

Problem 20-60

Given

```
eff = 0.1;
d = 0.08; %[m]
A = pi*d^2; %[m^2]
P = 60; %[W]
T_inf = 25; %[deg C]
```

```
epsilon = 0.9;
```

Solve

```
% Make a temperature guess
T_guess = 163; %[deg C]
```

Properties of Surrounding Air (Table A-22)

```
T_av = (T_guess + T_inf) / 2; %[deg C]
k = 0.03095; %[W/mK]
v = 2.306e-05; %[m^2/s]
Pr = 0.7111;
beta = 1/(T_av + 273);
```

Calculate Convection & Radiation

```
% Characteristic Length
L_c = d;

% Grashof Number
Gr_ = Gr(g,beta,T_guess,T_inf,L_c,v);

% Rayleigh Number
Ra_ = Gr_ * Pr;

% Nusselt Number
Nu_ = 2 + (0.589*Ra_)^0.25/(1 + (0.469/Pr)^(9/16))^(4/9);

% Find convection Heat coefficient
h = Nu_ * k / L_c; %[W/m^2K]

% Heat Balance Equation (with radiation)
%
% Q_dis = Q_conv + Q_rad

Q_in = P * (1 - eff);

Q_transfer = h*A*(T_guess - T_inf) + epsilon*sigma*A*((T_guess
+273)^4 - (T_inf+273)^4);

% After iterating across a couple of guesses to get the surface
% temperature such that the heat leaving through convection and
% radiation would be equal to the power absorption, the resulting
% surface temperature was:
fprintf('Problem 20-60: \n \n')
fprintf('Surface Temperature [deg C]: \n')
disp(T_guess)
```

```
Problem 20-60:

Surface Temperature [deg C]:
```

```
163
```

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