EP375 Computational Physics

Topic 9

OPTIMIZATION

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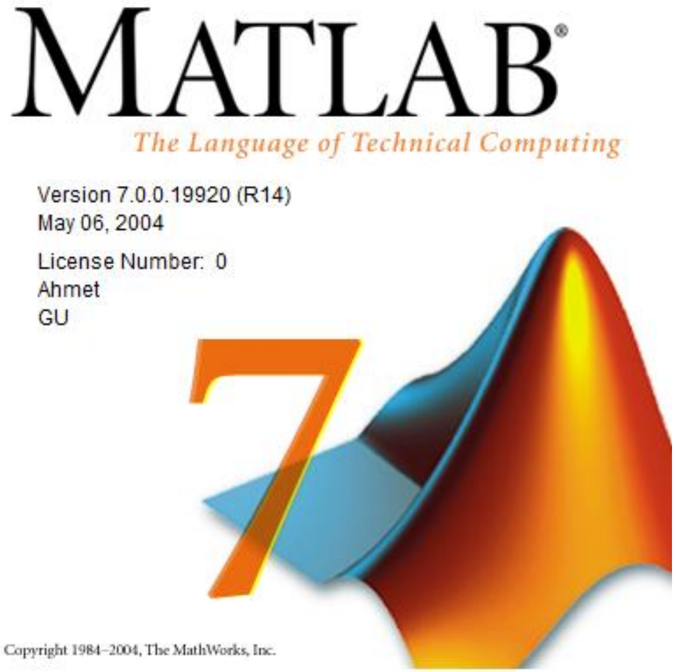


1. Introduction

- Optimization is the term used for minimizing or maximizing a function.

- In general, it is sufficient to consider the problem of minimization only; maximization of $f(x)$ is achieved by simply minimizing $-f(x)$.

- The function $f(x)$ that we want to optimze is called the **merit function** or **objective function**.

MATLAB `fminsearch()` Function

`x = fminsearch(@func, x0)`

returns the vector of independent variables that minimizes the multivariate function **`func`**.

The vector **`x0`** contains the starting values of **`x`**.

```
>> xopt = fminsearch(@sin,1)

xopt =

   -1.5708
```

Example:

Locate the minimum the function f(x) = exp(x)/x

optfun.m

```
function y = optfun(x)
  y = exp(x)/x;
end
```

```
>> xmin = fminsearch(@optfun, 0.4);
xmin = 1.0000
```

```
>> [xmin, fmin] = fminsearch(@optfun, 0.4);
xmin = 1.0000
fmin = 2.7183
```

Example:

Locate the minimum of the function

$$f(x, y) = 10x^2 + 3y^2 - 10xy + 2x.$$

Start with: $(x_0, y_0) = (0, 0)$.

optfun.m

```
function y = optfun(x)
 y = 10*x(1)^2 + 3*x(2)^2 - 10*x(1)*x(2) + 2*x(1);
end
```

```
>> x = fminsearch(@optfun, [0 0]);
x =

   -0.6000   -1.0000
```

HW 1

Locate the minimum of

$$f(x, y) = (x-10)^2 + (y - 4)^2 + (z - 0.9)^2 + 3(1 - x*y*z)$$

Start with: $(x_0 , y_0 , z_0) = (5, 5, 5)$.

HW 2

Find the maximum of the function

$$f(x, y, z) = -2x^2 - 3y^2 - z^2 + xy + xz - 2y$$

and confirm the result analytically.

HW 3

Using Plank's formula for a black-body radiator, derive Wein law:

$$k_B T \lambda_{\max} = 0.2014$$

or

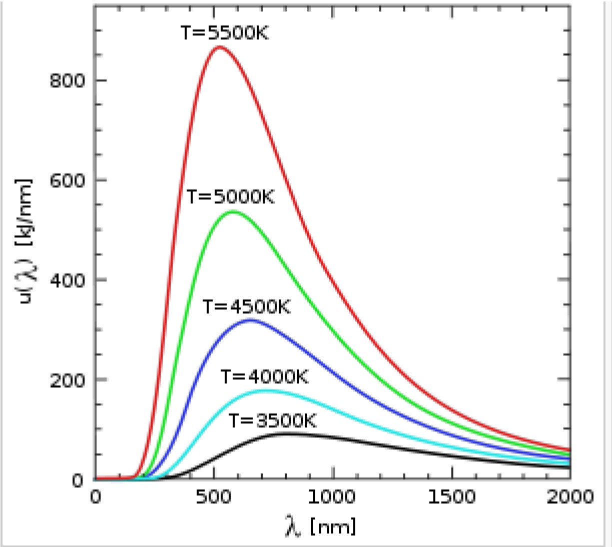
$$\lambda_{\max} T = 0.0029 \ \ \mathrm{m \cdot K}$$

Hint: Plank formula is given by:

$$u(\lambda) = \frac{8\pi hc}{\lambda^5} \frac{1}{\exp(hc / k_B T\lambda) - 1}$$

use dimensionless variable: $x = \dfrac{hc}{k_B T\lambda}$

and solve $\dfrac{du}{dx} = 0$

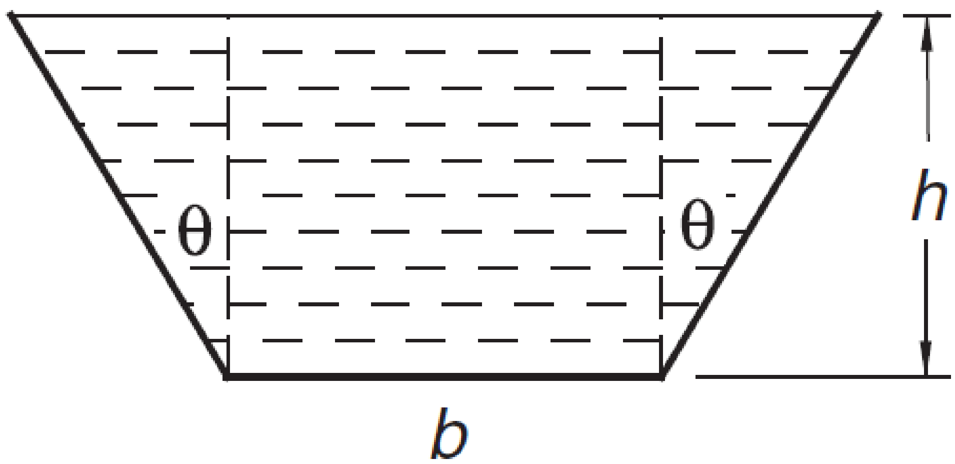


This diagram shows how the peak wavelength and total radiated amount vary with temperature according to Wien's displacement law. Although this plot shows relatively high temperatures, the same relationships hold true for any temperature down to absolute zero. Visible light is between 380 and 750 nm.

http://en.wikipedia.org/wiki/Thermal_radiation

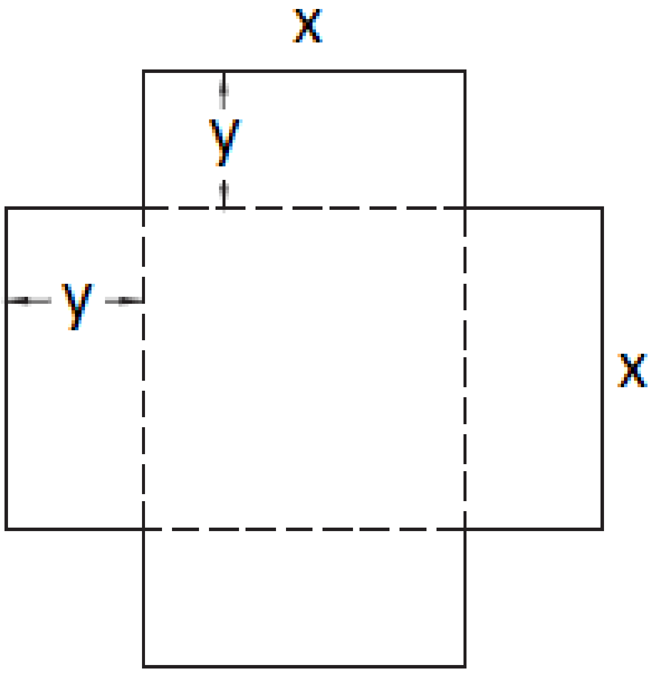
HW 4

The figure shows the cross section of a channel carrying water. Determine *h*, *b* and *θ* that minimize the length of the wetted perimeter while maintaining a cross-sectional area of 6 m^2. (Minimizing the wetted perimeter results in least resistance to the flow.)



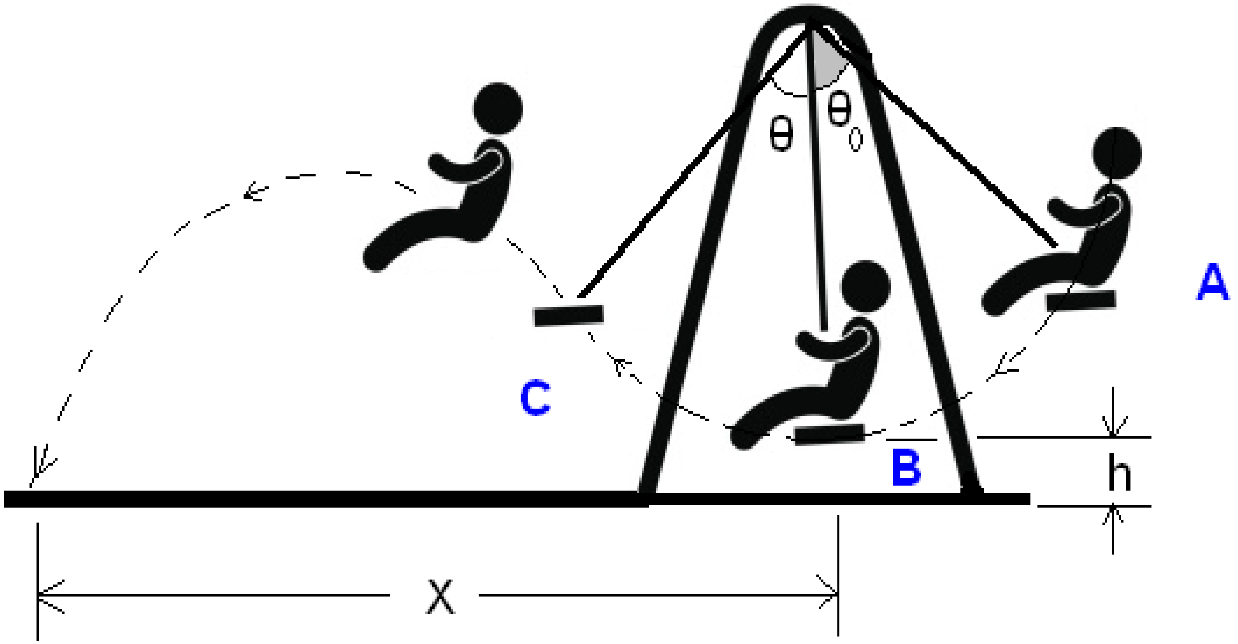
HW 5

Consider a box with open top to carry $V = 0.2\ m^3$ waste water. The cost of material used to form the box is $C_m = 10\ TL/m^2$ and welding cost is $C_w = 5\ TL/m$. Design the box so that its total cost is minimum. Verify the result analytically.



HW 6

A child starts to swing at an initial angle $\theta_0 = 60^o$ from point A. Then, he passes though the minimum point B as shown in figure. At point C where the angular position is $\theta < \theta_0$ he jumps from swing and falls down at a distance x from point B. Write a program to find the optimal value of θ such that the he can reach the maximum distance from the minimum point of the swing. Assume that the height of the swing is h = 0.5 m.



References

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