**ORDRE DES INGÉNIEURS DU QUÉBEC**

**MAY 2018 SESSION**

**Open book examination**
**Calculators: only authorized models**
**Duration: 3 heures**

**16-CH-A6 Process dynamics and control**

**Question 1 : (25 points)**

Obtain the transfer function y(t) for these 4 cases :

a) $Y(s)=\frac{S+1}{(S+3)(S+2)}$

b) $Y(s)=\frac{1}{(S+1)(S+2)}$

c) $Y(s)=\frac{S+3}{(S+1)^2}$

d) $Y(s)=\frac{S+2}{(S+1)(S+6)(S+7)}$

**Question 2 (25 points):**

A process has the following transfer function :

$$G_p(s)=\frac{323e^{-3s}}{4S^2+16S+4}$$

Describe the behavior of the process and find all the characteristic values related to the behavior.

**Question 3 (25 points):**

a)(15 points) Use the Routh-Hurwitz method to find the K value corresponding to the closed-loop system stability limit.

$$G_P(s)=\frac{K}{s(s+1)(s+7)}$$

b) (10 points) Do the same for this other system using the frequency analysis technique :

$$G_P(s)=\frac{K}{(s+2)(s+4)(s+6)}$$

**Question 4 (25 points):**

The CSTR below is controlled using cascade control. On the figure below you can see the reactant feed and the product outlet as well as the water-cooling jacket inlet and outlet, the water-cooling flow rate is controlled by the control valve on the left. The control information paths are also seen (dotted lines) between the actuators, controllers and sensors. Write the block diagram of the cascade control, identify clearly the disturbance which is associated with the cooling water fluctuations and explain why the cascade is used and the effect it has on the response of the system.