

**2004 – EE4008 – Test 2 (25% for each question)**

**Question 1**

The PID algorithm can be summarized as follows:

$$u_k = u_{k-1} + \left( K_p + \frac{K_i T}{2} + \frac{K_d}{T} \right) e_k + \left( \frac{K_i T}{2} - K_p - \frac{2K_d}{T} \right) e_{k-1} + \frac{K_d}{T} e_{k-2}$$

Use a flow chart to explain how you would implement this algorithm inside the digital controller.

**Question 2**

A 2<sup>nd</sup> order Butterworth filter has the following characteristics:

Order	$H_B(s)$
2	$\frac{1}{s^2 + 1.414s + 1}$

- Design a high pass filter  $H(s)$ , with a cut off frequency of  $\omega_0 = \sqrt{2}$ .
- Convert into digital form  $H(z)$ , using bilinear transformation integration. Assume the sampling time is T.

**Question 3**

For the function:  $F(z) = \frac{2z^2 + 3z}{z^2 + 4z - 5}$

- Find the A, B, C matrix of the controllable canonical form state space representation.
- Draw the flow diagram of the above function.

**Question 4**

With reference to the diagram below, describe (briefly and concisely) its operation principle.

