國立成功大學

114學年度碩士班招生考試試題

編　號：122

系　所：電機工程學系

科　目：控制系統

日　期：0210

節　次：第 2 節

注　意：1.不可使用計算機
2.請於答案卷(卡)作答，於試題上作答，不予計分。

1. (20%) A vertical launch rocket has mass m and thrust T. The rocket is subject to gravitational attraction with acceleration $g = g_0\left(\frac{R}{R+h}\right)^2$ where g_0 is a constant, R is the radius of the earth, and h is the altitude.

(a). **(10%)** Obtain the **differential equation** that describes the relationship between the thrust T and the altitude h.

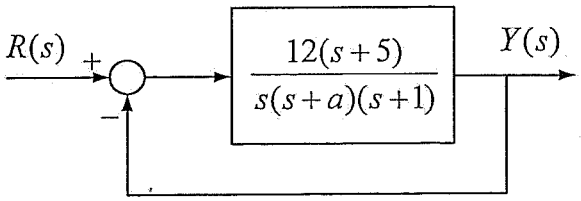
(b). **(5%)** Find the linear approximation at $h = 0$ and determine the **transfer function**.

(c). **(5%)** Evaluate the **poles** of the system.

2. (14%) In a unity negative feedback control system, the plant is a double integrator $G(s) = \frac{1}{s^2}$ and a PD controller $K(s) = k_p + k_d s$ is used. Determine the **conditions on** k_p **and** k_d so that the closed-loop system is stable and the phase margin is at least 45°.

3. (16%) For the control system in the following figure, complete the table concerning the **steady state error**.

Input $R(s)$	Parameter a	Steady state error
$1/s$	2	
$1/s$	4	
$1/s^2$	0	
$1/s^2$	4	



4. (25%) Consider a linear time invariant SISO 3rd order controllable state equation $\dot{\mathbf{x}}(t) = \mathbf{A}\mathbf{x}(t) + \mathbf{b}u(t)$ and let $\mathbf{z}(t) = \mathbf{T}\mathbf{x}(t)$, figure out and determine $\mathbf{T}$ such that $\dot{\mathbf{z}}(t) = \bar{\mathbf{A}}\mathbf{z}(t) + \bar{\mathbf{b}}u(t)$, where

$$\bar{\mathbf{A}} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -a_3 & -a_2 & -a_1 \end{bmatrix} \text{ and } \bar{\mathbf{b}} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}.$$

5. (25%) An asymptotically stable **type I** SISO system with input and output equations are described by $\dot{\mathbf{x}}(t) = \mathbf{A}\mathbf{x}(t) + \mathbf{b}u(t)$ and $\mathbf{y}(t) = \mathbf{c}\mathbf{x}(t)$. Suppose the input is given by the ramp function $u(t) = 5t$, for $t > 0$. Please derive and determine the velocity error coefficient, k_v, in terms of $\mathbf{A}$, $\mathbf{b}$, and $\mathbf{c}$.