[1] Answer the following questions with a choice (single choice) of ***T*** (True), ***F*** (False) and ***C*** (case by case). (30%)

(a) Once the value of K_D of a PD controller is fixed, increasing the value of K_P will increase the phase margin monotonically.

(b) Adding a zero to the loop transfer function will always increase the bandwidth of the closed-loop system.

(c) The phase-lead controller may not be effective if the negative slope of the uncompensated process transfer function is too steep near the gain-crossover frequency.

(d) Nichols chart can be used to find BW and M_r information of a closed-loop system.

(e) Bode plot can be used for stability analysis for minimum- as well as nonminimum-phase transfer functions.

(f) Th e following characteristic equation of a continuous-data system represents an unstable system since it contains a negative coefficient.

$$s^3 - s^2 + 5s + 10 = 0$$

(g) Increasing the undamped natural frequency will generally reduce the rise time of the step response.

(h) The following transfer function G(s) can be approximated by $G_L(s)$ since the pole at -20 is much larger than the dominant pole at s = -1

$$G(s) = \frac{10}{s(s+1)(s+20)} \qquad G_L = \frac{10}{s(s+1)}$$

(i) Given the equation: $1+KG_1(s)H_1(s)=0$, where $G_1(s)H_1(s)$ is a rational function of s, and dose not contain K, the roots of $\frac{dG_1(s)H_1(s)}{ds}$ are all breakaway points on the root loci ($-\infty<K<\infty$).

(j) Without modification, all the rules and properties for the construction of root loci in the s-plane can be applied to the construction of root loci of discrete-data systems in the z-plane.

[2] Consider the discrete-time system

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 2 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} r(k), \quad y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

With $r(k) = u(k) - u(k-2)$, where $u(k)$ is the unit-step input, and $x_1(0) = 0$, $x_2(0) = 0$

Find $y(k)$ (10%)

（背面仍有題目,請繼續作答）

[3] The block diagram of a linearized idle-speed engine-control system of an automobile is shown in Fig. 1. The system is linearized about a nominal operating point, so all the variables represent linear-perturbed quantities. The following variables are defined: $T_m(t)$ is the engine torque; T_D the constant load-disturbance torque; ω(t), the engine speed; u(t), the input-voltage to the throttle actuator; and α, the throttle angle. The time delay in the engine model can be approximated by (20%)

$$e^{-0.2s} \cong \frac{1-0.1s}{1+0.1s}$$

(a)Draw a state diagram for the system by decomposing each block individually. Assign the state variable from right to left in ascending order.

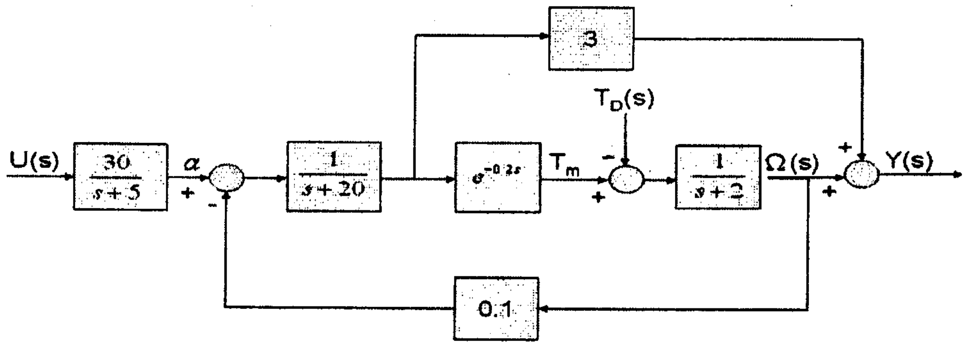

FIG. 1

(b) Write the state equation from the state diagram obtained in part (a), in the form of

$$\frac{d\mathbf{x}(t)}{dt} = \mathbf{A}\mathbf{x}(t) + \mathbf{B}\begin{bmatrix} u(t) \\ T_D(t) \end{bmatrix}$$

(c) Write Y(s) as a function of U(s) and T_D(s). Write Ω(s) as a function of U(s) and T_D(s).

[4] The block diagram of a feedback control system is shown in Fig. 2 (15%)

(a) Apply the Nyquist criterion to determine the range of K for stability.

(b) Check the answer obtained in part (a) with the Routh-Hurwitz criterion.

$$G(s) = \frac{K}{(s+4)(s+5)}$$

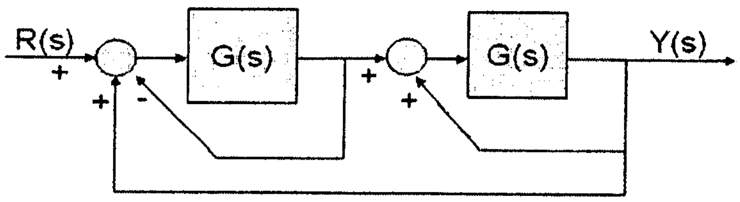

FIG. 2

[5] A block diagram of a control system is shown in Fig. 3. (15%)

(a) Determine the system completely state controllable and observable of the systems, conditions on the A, B, C, and D matrices.

(b) Determine the system completely state controllable and observable of the systems, conditions on the pole-zero cancellation of the transfer function Y(s)/U(s).

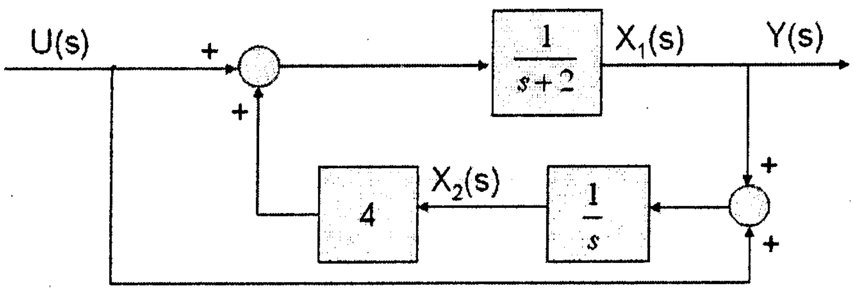

FIG. 3

[6] A R-C circuit system is shown in Fig4. The fixed parameter of the system are given as R=1Ω, C=1F. (10%)

(a) Find the transfer function $\frac{Y(z)}{R(z)}$

(b) When input voltage $r(t) = e^{-t}(v)$, Find output voltage $y(kT)$.

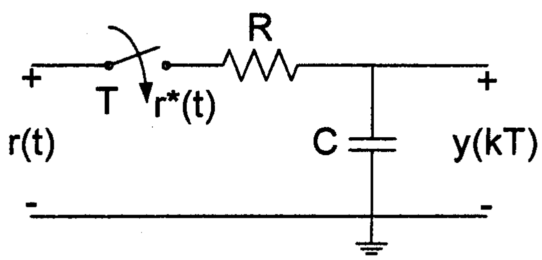

FIG. 4