國立臺灣科技大學 104 學年度碩士班招生試題

系所組別：電機工程系碩士班丁二組

科　　目：控制系統與數位邏輯

(總分為 100 分)

Problem 1: Logic design short questions (簡答題 50 points, 5 points each)

(1) For addition of two n-bit 2's complement signed integers X and Y, and A is the sum of X and Y, how can you detect an overflow has occurred?

(2) For addition of two n-bit 2's complement signed integers X and Y, how can you avoid overflows and obtain the correction sum?

(3) Write down DeMorgan's laws of Boolean expressions.

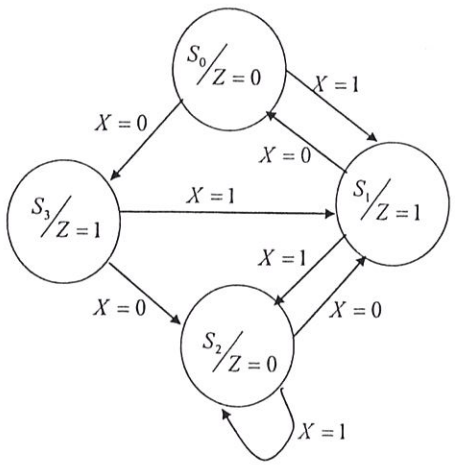
(4) Prove the Consensus Theorem XY+X'Z+YZ = XY + X'Z.

(5) Define a minimal sum of products expression.

(6) Convert a D flip-flop to a J-K flip-flop by adding external gates.

(7) Convert a D flip-flop to a T flip-flop by adding external gates.

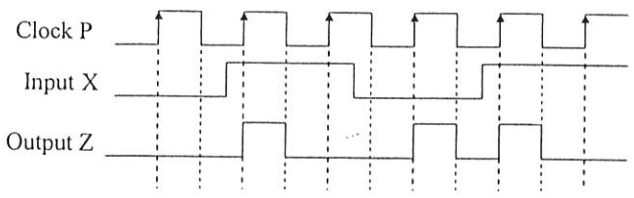
(8) For the following Moore state graph, draw the next-state and output maps.



State	AB
S_0	00
S_1	01
S_2	11
S_3	10

(9) For the state graph above, find the next-state and output equations:
$A^+ = ?, B^+ = ?$ and $Z = ?$

(10) Design a sequence circuit such that the output Z generates a clock pulse whenever the asynchronous input X has level changes, as shown below.



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Problem 2: (25 points)

Consider the model of DC motor in Fig. 1, where $e_i, i, R, L, e_b, \omega, \theta, \tau, \tau_l$ and τ_f denote input voltage, current, resistance, inductance, back emf, angular velocity, angular position, motor torque, load torque and friction torque, respectively. The corresponding motor possesses the rotor inertia J and the viscous-friction coefficient B such that inertia torque $J\dot{\omega}$ and friction torque $\tau_f = B\omega$ exist. In addition, the following relations: $\tau = K_i i$, $e_b = K_b \omega$, where K_i and K_b are respectively torque constant and back-emf constant, exist. (a) Find the state equation and output equation of DC motor system with state $x^T = [x_1 \quad x_2 \quad x_3], x_1 = \theta, x_2 = \omega, x_3 = i$, input $u = e_i$, and output $y = \theta$, respectively. (15 points). (b) Draw the block diagram of this DC motor system with transfer function. (10 points)

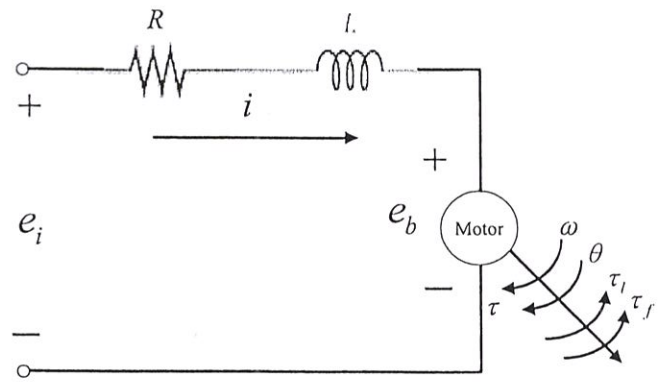

Fig. 1. Model of DC motor.

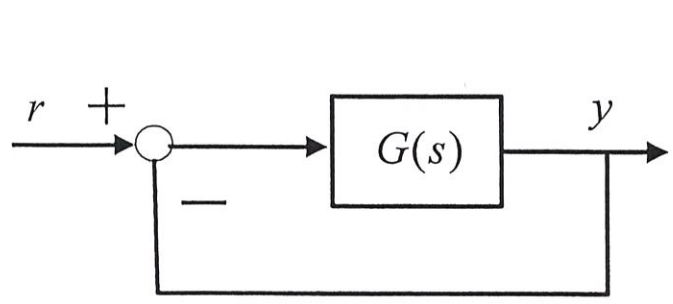

Fig. 2. A feedback delay system.

Problem 3: (25 points)

Consider the control system Fig. 2 with $G(s) = Ke^{-\tau s} / \{s(s+1)(s+2)\}$. (a) For $K = 1$ and $\tau = 0$, find the gain crossover frequency ω_g, i.e., $|G(j\omega_g)| = 1$, the phase margin (PM). (10 points). (b) For part (a), find the critical delay for the stability. Give some comments. (5 points). (c) For $\tau = 1$, find the phase crossover frequency ω_p, i.e., $\angle G(j\omega_p) = -\pi$, and the critical gain K in dB for stability. (10 points)