

國立台灣科技大學一百學年度碩士班招生試題

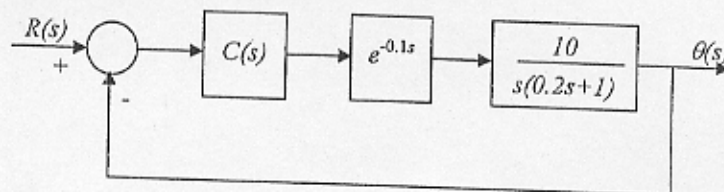
系所組別：機械工程系碩士班丁組

科目：系統控制

(總分為100分)

題目共四題，總分 100 分，每小題有標示所占分數

1. Answer the questions briefly.
 - (a) What is a "dynamic system," and what is the "system dynamics"? (4%)
 - (b) What is the difference between "automation" and "automatic control"? (4%)
 - (c) What is "real-time control" and "embedded controller"? (4%)
 - (d) State the procedure for tuning a PID controller. (4%)
 - (e) What is the equilibrium point of the system $\dot{x} = -x + \sin t$? (4%)
2. A tank is used in storing fuel for a power unit where the fuel level metering is imperative in keeping the supply precision. Regulation of the level is realized by a control system with proper robustness. Suppose the fuel input is denoted by Q_m and the output is Q_{out} . It is known that the time derivative of the fuel level λ is proportional to the fuel input minus the fuel output.
 - (a) Please write down the system model in a differential equation form. (4%)
 - (b) If the fuel output is proportional to the fuel level, rewrite the system model. (4%)
 - (c) Express the system in a state space form. (4%)
 - (d) What is the input and output of the system. (4%)
 - (e) Is the system stable? Why? (4%)
3. A DC motor is modeled as below, where the output is the angular position of the shaft (θ), and a 0.1 sec of delay is present due to the hardware. The task is to design the controller $C(s)$ so that the angular position tracks the desired reference $R(s)$.
 - (a) Roughly sketch the Bode plot of the uncompensated system using the asymptotes and estimate the phase margin. (10%)
 - (b) An engineer designs the controller as $C(s) = \frac{10(s+5)e^{0.1s}}{(s+20)}$, estimate the overshoot, rise time, and settling time in the step response of the compensated system. How do you modify this design to reduce the settling time? Comment on the problems of this design in the practical application. (10%)
 - (c) Another engineer, not too sensible either, proposes a different design as $C(s) = \frac{(2+s)}{(2-s)}$, claiming that the phase lead associated with this controller can compensate for the extra phase lag caused by the delay. To overrule his design, give specific reasons in s-plane and frequency response to show that his design will not work. To correct his mistake, how can you modify the parameters of his "lead filter" to improve the stability if he insists on using a right half plane pole? (10%)



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4. A control system is described in the figure below, and the parameters a and b ($a, b \in \mathbb{R}$) are to be designed as the controller gains.
- (a) Derive the transfer functions relating the output $Y(s)$ to the reference input $R(s)$ and to the disturbance input $W(s)$. (10%)
- (b) Defining the error as $E(s) = R(s) - Y(s)$, what is the system type of this system in relation to the reference input $R(s)$? What is the corresponding error constant? (10%)
- (c) Find the conditions relating the parameters a and b such that the closed-loop system is stable. (10%)

