1、 (25%) The type I **diabetes**(糖尿病) is caused by lesion in the **pancreas**(胰臟) of patients. The patient's beta cells in pancreas can not secrete insulin(胰島素) which can assist the break-down of glucose(葡萄糖) in muscle cells and the glucose concentration in blood stream remains high. For the past two decades, biomedical engineers have been working on a device (control system) that can sense the glucose level in blood stream and inject right amount of synthesized insulin into the body. Recent developments in micro-electro-mechanical systems have provided us miniaturized glucose sensor and insulin micro pump to deliver insulin. If you are the project engineer of a biotechnology company and your job is to develop an implantable(植入式) artificial pancreas. Design such a system and draw a block diagram of your system and provide a design procedure for this product. What kinds of engineering analysis are to be performed? What kinds of control algorithms can be used for such control system?

2、 (25%) What is the **root-locus** method? Using the root-locus method to explain that proportional feedback for a third-order system may result in an unstable system, if the gain is too high. Assume that the third-order system has three poles located at left half S-plane and no zero. Show that a <u>p</u>roportional-plus-<u>d</u>erivative (PD) control can be used to improve relative stability of the third-order system.

(背面仍有題目,請繼續作答)

3. Prove that the sinusoidal signal is invariant under the transformation of a linear time –invariant system.
(20%)

4. Consider a unity feedback system with proportional controller K and plant G(s)=exp(-0.1s)/(s+4) . Select K such that the phase margin of the system is 40°. Determine the gain margin for the selected gain K.
(15%)

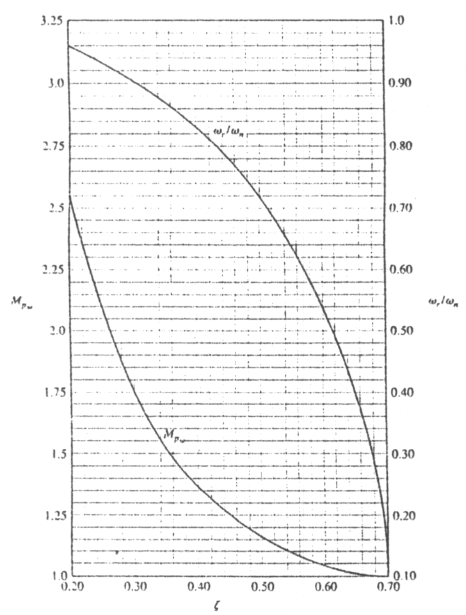
5.Consider a unity feedback control system with proportional controller K and plant G(s)=1/(s(s+1)(s+2)). Assume that the system has dominated second-order poles; find the control gain K to satisfy:

1) percent of overshoot=35%±5%
2) settling time=15±3sec.

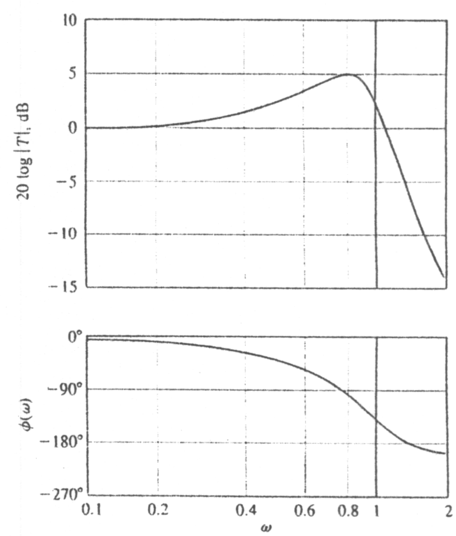
(15%)

You may need the following design graphs.

The maximum of the frequency response, M_{p_ω}, and the resonant frequency, ω_r, versus ζ for a pair of complex conjugate poles.



Bode diagram for closed-loop system.



Percent overshoot and normalized peak time versus damping ratio ζ for a second-order system