

# 國立成功大學

## 113學年度碩士班招生考試試題

編 號：170

系 所：電機工程學系

科 目：電儀表學

日 期：0201

節 次：第 2 節

備 註：可使用計算機

※ 考生請注意：本試題可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. {15 pts} (a) Explain the advantages of electronic multimeter (EMM) over volt-ohm-milliammeter (VOM) in aspects of sensitivity and input impedance. {5 pts} (b) As shown in Figure 1, given that the measured  $E=7.5\text{ V}$ ,  $I_m(\text{FSD}) = 1\text{ mA}$ ,  $V_p=+5\text{ V}$ ,  $V_{GS}=-5\text{ V}$ ,  $R_s+R_m = 1\text{ k Ohm}$ , and the switch turns to the third position (10 V), please find the voltage (V) across the emitters of  $Q_1$  and  $Q_2$ . {5 pts} (c) What is the current through the meter? {5 pts}

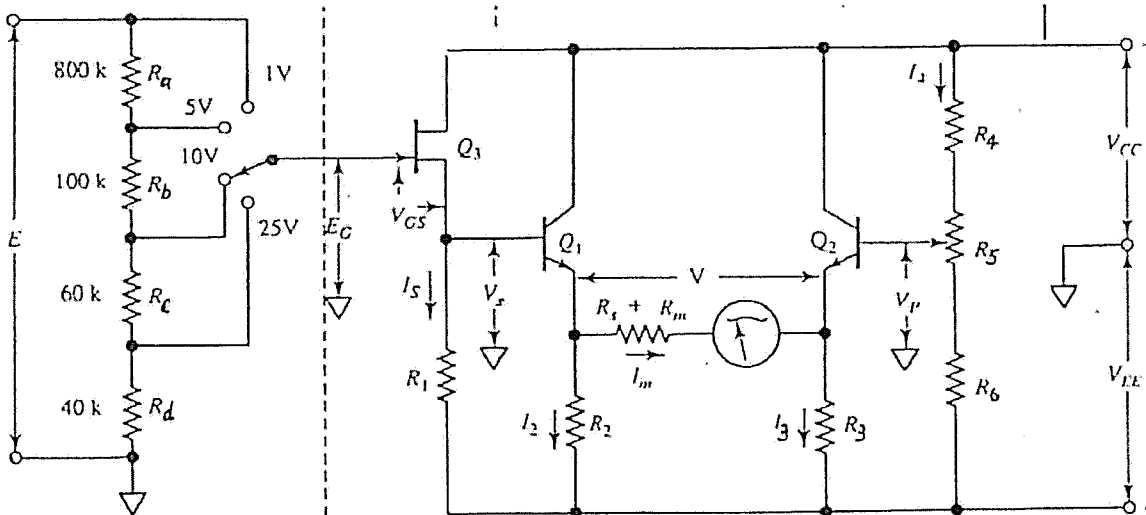


Figure 1

2. {10 pts} (a) Please describe and explain two sources of inherent errors in all frequency and period counters. {5 pts} (b) If the frequency of a signal is 2.38 MHz and a five-digit DCA in a frequency counter reads 23800, please calculate the time base of this frequency counter. {5 pts}
3. {15 pts} As shown in Figure 2, a Zener diode is used to regulate the output voltage ( $V_{out}$ ), where  $V_{in}$  is 8 V,  $R$  is 50 Ohm, and the breakdown voltage  $V_{Z0}$  and dynamic impedance  $r_z$  of the Zener diode is 5 V and 2 Ohm, respectively. If the desired output voltage ( $V_{O\_goal}$ ) of the circuit is 5 V. (a) Please calculate the actual value of  $V_{out}$  when the equivalent load resistance ( $R_L$ ) is 100 Ohm. {5 pts} (b) Please recalculate the actual value of  $V_{out}$  when  $R_L$  is 1k Ohm. {5 pts} (c) According to the results in (a) and (b), please calculate the load regulation of this circuit. {5 pts}

$$[\text{Load regulation} = \frac{\Delta V_{out}}{V_{O\_goal}} \times \frac{1}{\Delta I_L} \times 100\%, \text{ Unit: \% / A}]$$

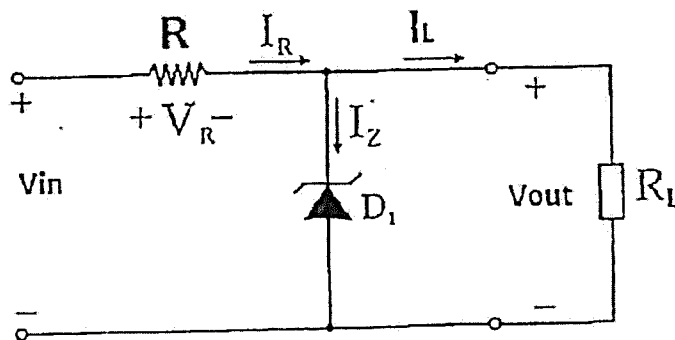


Figure 2

4. {0pts} Please explain how the phase detector works using Figure 3.

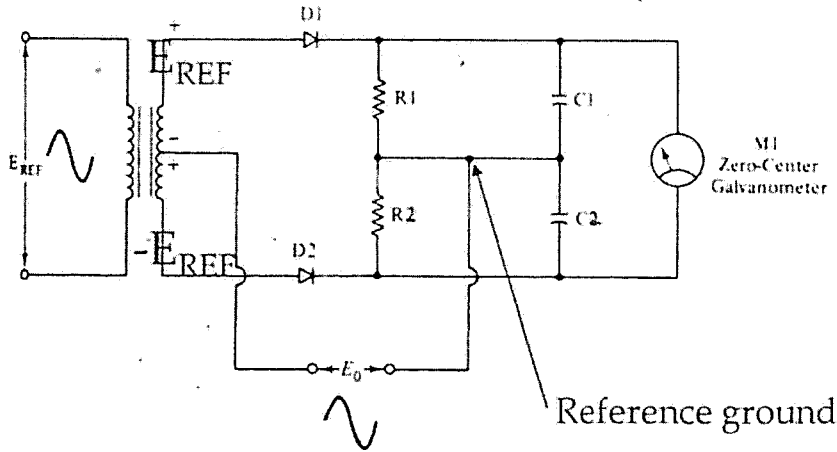


Figure 3

5. {15 pts} (a) Plot function blocks to build a frequency counter including time base, main gate, decade counter assembly (DCA) and so on. (b) Normal human beings have heartbeat rate of 68 beat per minute (bpm) and breath beat rate of 18 bpm. We try to measure this biological parameter accurately. To design a heartbeat pulsimeter (i.e., sphygmometer 脈搏計) using a reciprocal counting technology, let the time base = 1 ms, evaluate the counting number of a  $3^{1/2}$  meter and their relative errors of the measured frequency.

6. {20 pts} Given a spectrum analyzer based on superheterodyne architecture, (a) plot the function blocks of a superheterodyne receiver, (b) write the formula between the input and output of a mixer; (c) considering the input signal range: 7.2 GHz ~ 10.1 GHz with intermediate frequency (IF) filter = 3.6 GHz, find frequency range of local oscillator (LO).

7. {15 pts} A practical capacitor with parasitics (model #1 in Figure 4) is measured at 400 kHz, and the parameters are extracted:  $[L_s, R_s, R_p, C_p] = [0.5 \mu\text{H}, 0.1 \Omega, 100 \Omega, 4.7 \mu\text{F}]$ . (a) Please estimate the  $C_{s,eq1}$  and  $R_{s,eq1}$  based on simplified model (model #2, series type). (b) Calculate the quality factor of this capacitor.

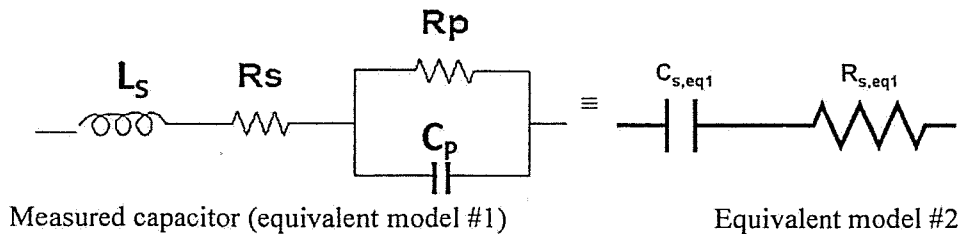


Figure 4