國立成功大學

113學年度碩士班招生考試試題

編　號：41

系　所：光電科學與工程學系

科　目：電子學

日　期：0202

節　次：第 1 節

備　註：不可使用計算機

編號： 41

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1. A sensor producing a voltage of 1.2 V rms with a source resistance of 1 MΩ is available to drive a 10-Ω load. If connected directly, what voltage and power levels result at the load? If a unity-gain (i.e., A_{vo} = 1) buffer amplifier with 1-MΩ input resistance and 10-Ω output resistance is interposed between source and load, what do the output voltage and power levels become? For the new arrangement, find the voltage gain from source to load, and the power gain (both expressed in decibels, hint: log(2) = 0.30, log(3) = 0.48, log(5) = 0.70, 15%).

2. Consider a diode-connected NMOS transistor fed with a constant current of 0.5 mA. Assume λ = 0. (10%)
(a) If at 20°C, V_t = 0.5 V and k_n = 1 mA/V^2, find V_{GS}.
(b) If the temperature rises to 60°C, find the resulting V_{GS} given that V_t changes by −2mV/°C and k_n' changes by −0.25%/°C. (hint: $\sqrt{2}$=1.41, $\sqrt{3}$=1.73, $\sqrt{5}$=2.24)

3. For the circuit in Fig. 1, find values for labeled node voltages and branch currents. Assume β =100 and V_{BE} = 0.7 V.　(15%)

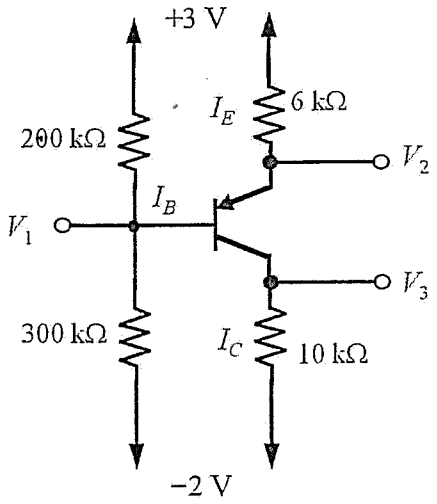

Fig. 1

4. A voltage regulator consisting of two diodes in series fed with a constant-current source is used as a replacement for a single carbon–zinc cell (battery) of nominal voltage 1.5 V. The regulator load current varies from 2 mA to 7 mA. Constant-current supplies of 5 mA, 10 mA, and 15 mA are available. Which would you choose, and why? What change in output voltage would result when the load current varies over its full range?　(Assume thermal voltage = 25 mV, ln(2)=0.69, ln(3)=1.10, ln(5)=1.61, ln(13)=2.56, 10%)

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5. An emitter follower, when driven from a 10-kΩ source, was found to have an output resistance R_{out} of 125 Ω. The output resistance increased to 225 Ω when the source resistance was doubled. Find the overall voltage gain when the follower is driven by a 10-kΩ source and loaded with a 1-kΩ resistor. (10%)

6. (a) For the circuit in Fig. 2, assume BJTs with high β and v_{BE} =0.7 V at 1 mA. Find the value of R that will result in I_O = 10 μA. (10%) (b) For the design in (a), find R_O assuming β = 100 and V_A = 40 V. (10%)

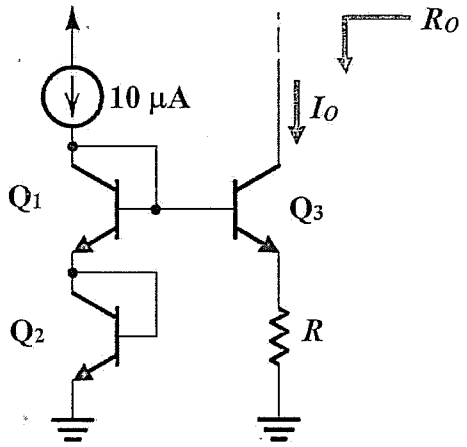

Fig. 2

7. The differential amplifier of Fig. 3 is biased with I = 200 μA. All transistors have L = 0.5 μm, and Q_1 and Q_2 have W/L = 20. The circuit is fabricated in a process for which $\mu_n C_{ox}$ = 400 μA/V^2 and $|V'_A|$ = 6 V/μm. Find $g_{m1,2}$, r_{o2}, r_{o4}, and A_d. (20%, each 5%)

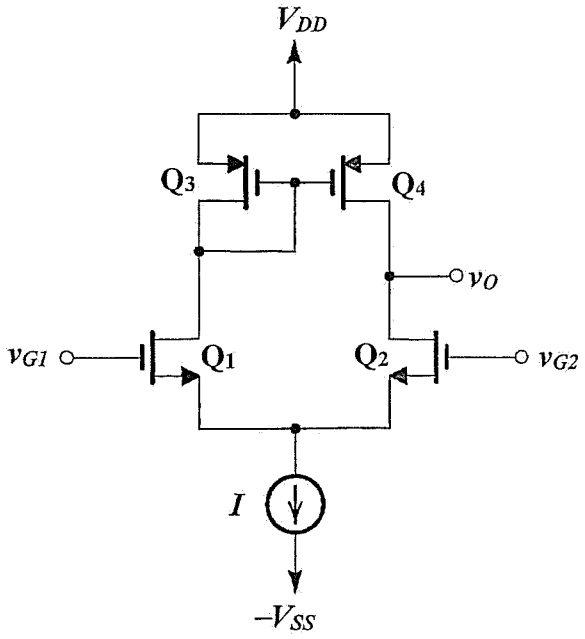

Fig. 3