

OLLSCOIL NA hÉIREANN, GAILLIMH  
NATIONAL UNIVERSITY OF IRELAND, GALWAY

SUMMER EXAMINATIONS, 2000

SECOND ELECTRONIC ENGINEERING  
SECOND ELECTRONIC AND COMPUTER ENGINEERING

ANALOGUE SYSTEMS DESIGN I

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Duration of examination: *Three* hours

Instructions: Answer *four* questions

1. (a) Derive an expression for the gain of the circuit shown in figure 1. State clearly any assumptions made in your derivation. [6 marks]

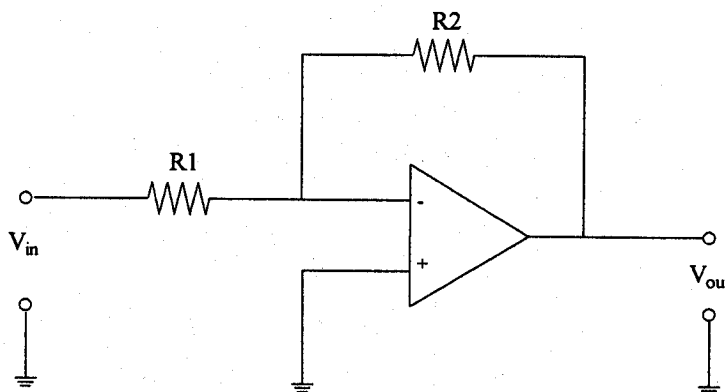


Figure 1

- (b) Using the values of  $R1 = 10\text{k}\Omega$  and  $R2 = 5\text{k}\Omega$  and an input voltage of  $V_{in}(t) = 10\sin(100\pi t)$  plot two cycles of the output voltage  $V_{out}(t)$ . [4 marks]
- (c) Design a summing circuit which accepts inputs  $V_1(t)$ ,  $V_2(t)$ ,  $V_3(t)$  and  $V_4(t)$  and produces one output according to the following equation :

$$V_3(t) = -\{ V_1(t) + 10V_2(t) + 0.5V_3(t) + 0.1V_4(t) \}$$

[10 marks]

2. (a) Describe *four* non-ideal characteristics of an operational amplifier. [4 marks]
- (b) Give the circuit diagram for a simple active low-pass filter. The filter is to have a cut off frequency of 3.8kHz. Sketch the frequency response of the circuit. [6 marks]
- (c) The circuit of figure 3 below may be used to supply a constant current to a variable load  $R_L$ . Derive an expression for the current  $I_L$  in this circuit. Specify the value of  $I_L$  if  $V_{in}=10V$  [10 marks]

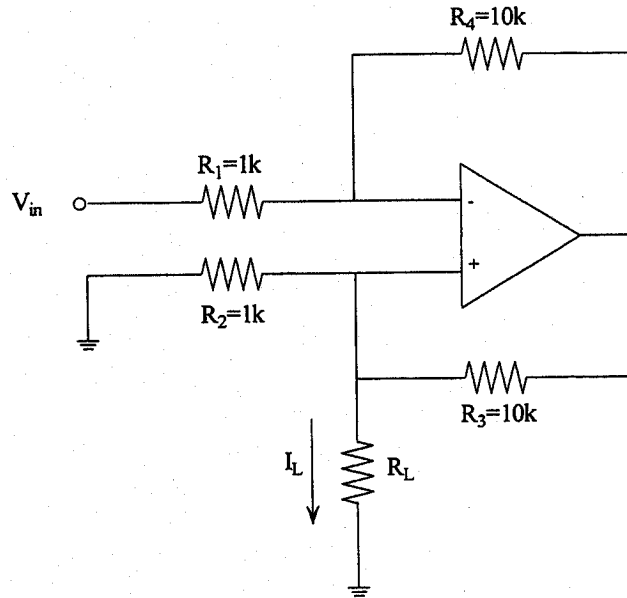


Figure 2

3. (a) Explain with the aid of diagrams the structure and operation of an n-channel Junction Field Effect Transistor (JFET). [5 marks]
- (b) For the circuit of figure 3 below determine  $V_G$ ,  $I_D$  and specify the DC output voltage of the circuit  $V_O$ . [15 marks]

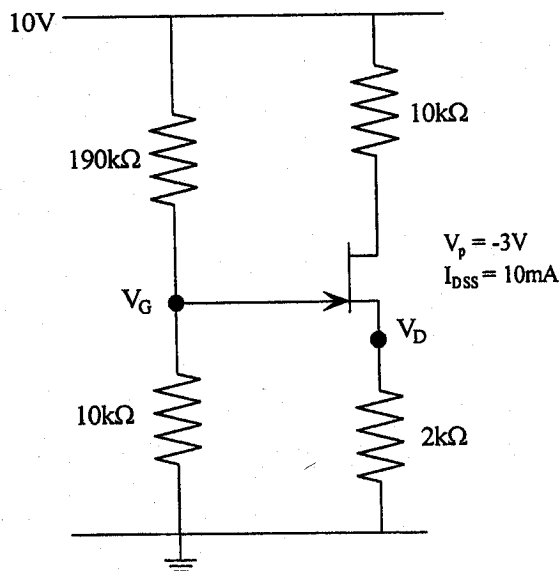


Figure 3

4. (a) Explain with the aid of diagrams the structure and operation of an n-channel enhancement mode Metal Oxide Field Effect Transistor (MOSFET). [5 marks]
- (b) For the circuit of figure 4 below determine  $V_G$ ,  $I_D$  and specify the DC output voltage of the circuit  $V_O$ . Note the following

$$V_T = 2V$$

$$I_D = 0.25mA \text{ @ } V_{GS} = 2.5V$$

[15 marks]

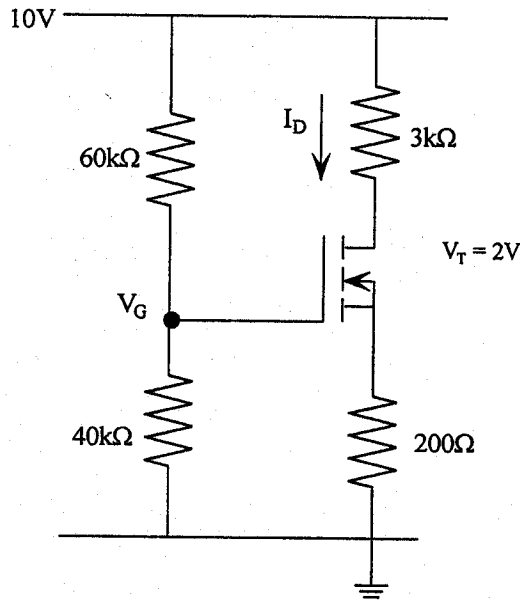


Figure 4

5. (a) Explain briefly the purpose of biasing a transistor amplifier. [2 marks]
- (b) Determine the Thévenin equivalent of the base biasing circuit of transistor amplifier of figure 5. Specify the value of the DC base current  $I_B$ . [6 marks]
- (c) Proceed to determine the following DC values:  $V_B$ ,  $V_E$ , and  $V_C$ . [6 marks]
- (d) Assuming  $V_B$  increases by +0.2Volts due to the application of an external input, calculate the resulting change in  $V_E$ ,  $I_E$ ,  $I_C$  and  $V_C$ . If the output voltage is taken from the collector what is the voltage gain of the circuit. [6 marks]

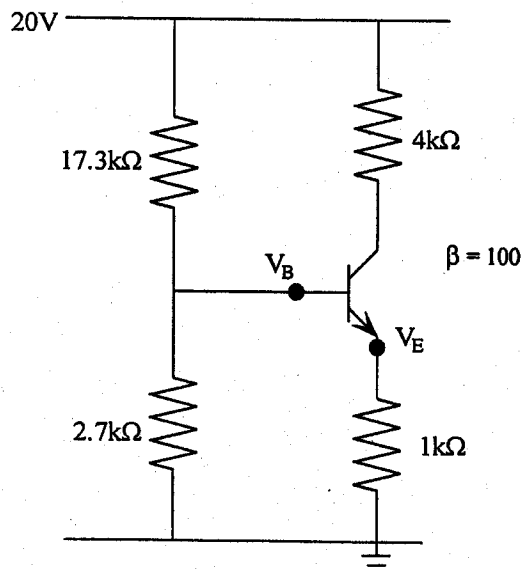


Figure 5

6. (a) Explain the purpose of including  $C_B$ ,  $C_O$  and  $C_E$  in the common-emitter amplifier circuit of figure 6. [4 marks]
- (b) Determine the DC values of  $V_B$ ,  $I_E$  and  $I_C$  and state if the transistor is operating in the active region. [6 marks]
- (c) Specify the value of for the voltage gain of the circuit. [5 marks]
- (d) If the input voltage  $v(t)$  is a sinusoid voltage of peak value  $V_p=10\text{mV}$  sketch the output voltage waveform over two cycles. [5 marks]

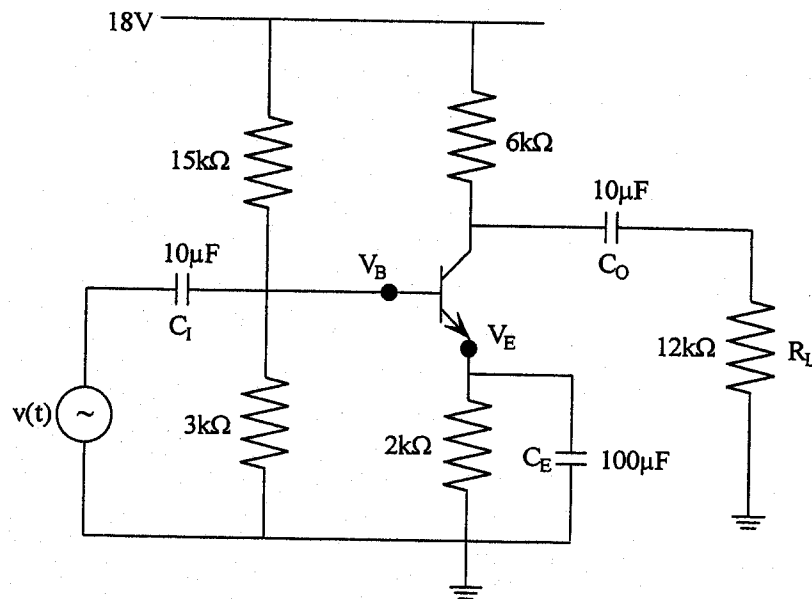


Figure 6