

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

GX 701

Semester II Examinations, 2003/2004

Exam Code(s)	3BN121
	3BP121
Exam(s)	Third Year Electronic Engineering
	Third Year Electronic and Computer Engineering
Module Code(s)	EE322
Module(s)	Analogue Systems Design I
Paper No.	1
Repeat Paper	Special Paper
External Examiner(s)	Professor S. McLaughlin
Internal Examiner(s)	Professor D.J. Wilcox
	Dr. J. Breslin
	Dr. M. Duffy

Instructions:

Answer 3 questions.
All questions carry equal marks.

Duration	2hrs
No. of Answer books	1

Requirements:

Handout	_____
MCQ	_____
Statistical Tables	_____
Graph Paper	_____
Log Graph Paper	_____
Other Material	_____

No. of Pages	5
Department(s)	Electronic Engineering

1.

- (a) For the half-wave rectifier circuit with a real diode as shown in Fig. 1:

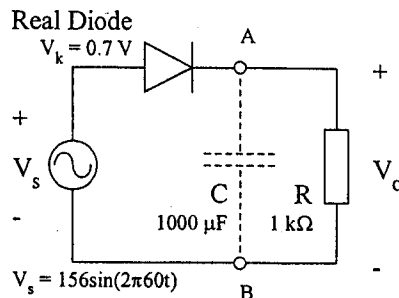


Fig. 1

- (i) Sketch the output waveform V_o without the capacitor C in the circuit. [2 marks]
- (ii) Describe the effect on V_o of placing the capacitor C in parallel with the load, i.e. between points A and B in the circuit. [3 marks]
- (iii) Calculate the ripple voltage if C is included. [2 marks]
- (iv) Explain how this circuit could be modified to function as a peak detector. [2 marks]

- (b) For the Zener diode voltage regulator circuit given in Fig. 2:

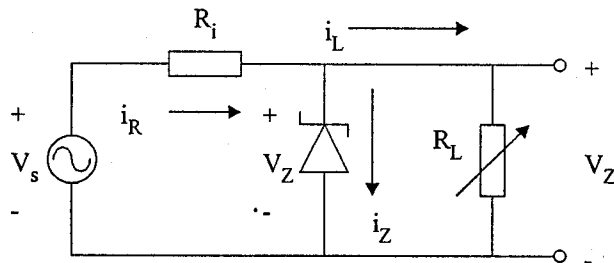


Fig. 2

- (i) Sketch the i_D vs. v_D characteristic for a Zener diode showing the various regions of operation. [2 marks]
- (ii) In which region does the Zener diode operate for the voltage regulator application shown? [1 mark]
- (iii) For varying source voltage and load current, analyse the circuit to determine the proper range of values for R_i that will allow the diode to maintain a constant output voltage (by keeping the Zener current between its minimum and maximum values). [6 marks]
- (iv) Define percentage regulation for the Zener diode voltage regulator. [2 marks]

[cont'd]

2.

In the emitter follower circuit of Fig. 3, a transistor with $\beta = 100$ is used.

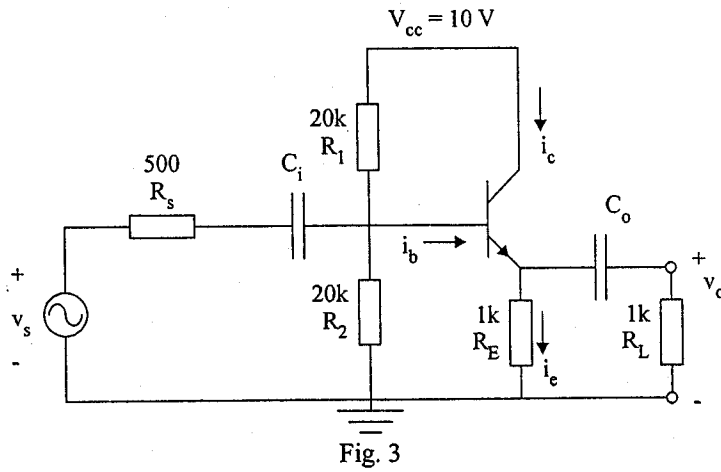


Fig. 3

(a) Complete the box model by calculating the following quantities:

- (i) Open loop gain
- (ii) Input resistance
- (iii) Output resistance

[15 marks]

(b) With the source and load connected, find the system gain.

[3 marks]

(c) What are the advantages of using an emitter follower in combination with a common emitter amplifier over other types of multi-stage amplifier systems?

[2 marks]

3.

(a) Show how the hybrid-pi and h-parameter AC models for the npn BJT can be made equivalent to each other.

[5 marks]

(b) The common emitter circuit shown in Fig. 4 has a 2N2222 transistor with these device parameters: $\beta = 255$, $C_e = 20.8$ pF, $C_c = 7.62$ pF, $\tau_F = 412$ ps. Find the complete frequency response and sketch the Bode gain.

[15 marks]

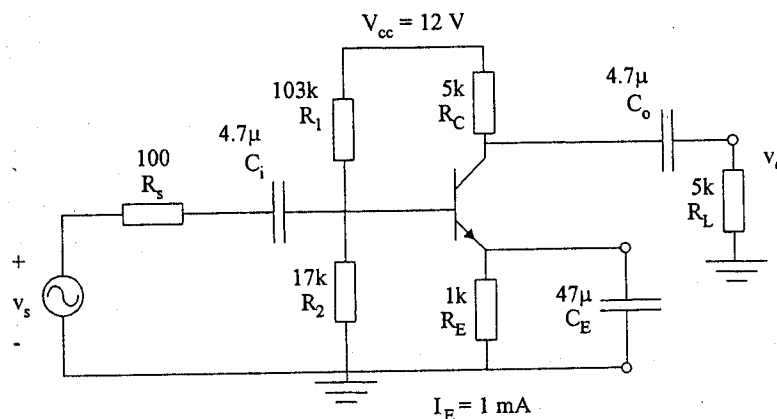


Fig. 4

[cont'd]

4.

A moving coil meter with an internal resistance of $1\text{ k}\Omega$ and a full-scale deflection current rating of 0.5 mA is to be used in the design of a DC voltmeter.

- (a) Describe the circuit required to increase the input voltage range of the meter. Use this circuit to design a voltmeter with input range of 100 V .

[5 marks]

- (b) Calculate the percentage error contributed by the voltmeter in measuring V_o in the circuit of Fig. 5(a).

[4 marks]

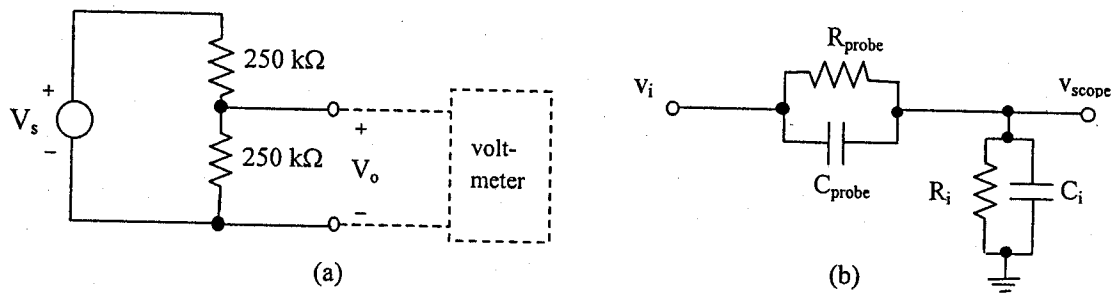


Fig. 5(a). Voltage test circuit, (b) Circuit model of oscilloscope with probe

The circuit diagram of a $\times 10$ probe connected to an oscilloscope is shown in Fig. 5(b).

- (c) Explain why $R_{\text{probe}}C_{\text{probe}}$ must equal R_iC_i for accurate display of input voltage waveforms.

[6 marks]

- (d) Design a $\times 10$ oscilloscope probe with $R_{\text{total}} = 10\text{ M}\Omega$ and $C_{\text{total}} = 12\text{ pF}$.

[5 marks]

[cont'd]

5.

A resistive strain gauge circuit consists of one active element and 3 dummy elements as shown in Fig. 6. When subjected to pressure, the strain on the active gauge increases, causing its resistance to increase by ΔR .

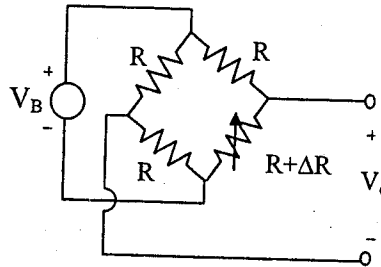


Fig. 6. Strain gauge bridge circuit

(a) Define what is meant by the following terms as they relate to sensors :

- (i) accuracy
- (ii) range
- (iii) sensitivity
- (iv) resolution

[6 marks]

(b) Give two reasons why Wheatstone bridge circuits are used in building sensor circuits.

[4 marks]

(c) For the sensor in Fig. 6 :

- (i) Write an expression for the output voltage as a function of ΔR , R and V_B .
- (ii) Calculate the percentage linearity error for $R = 3.5 \text{ k}\Omega$ and $\Delta R = 3.5 \text{ }\Omega$.
- (iii) Draw a bridge configuration with zero linearity error. Include an expression for its output voltage

[6 marks]

(d) Draw a block diagram for a sensor circuit that provides a digital output with a current sink. Explain the operation of the current sink.

[4 marks]