

Autumn Examinations, 2004

Exam Code(s)	<u>3BN121</u>
	<u>3BP121</u>
Exam(s)	<u>Third Year Electronic Engineering</u>
	<u>Third Year Electronic and Computer Engineering</u>

Module Code(s)	<u>EE322</u>
Module(s)	<u>Analogue Systems Design I</u>

Paper No.	<u>1</u>
Repeat Paper	<u>Yes</u> Special Paper _____
External Examiner(s)	<u>Professor S. McLaughlin</u>
Internal Examiner(s)	<u>Professor D.J. Wilcox</u>
	<u>Dr. J. Breslin</u>
	<u>Dr. M. Duffy</u>

Instructions:

Answer 3 questions.
All questions carry equal marks.

Duration	<u>2hrs</u>
No. of Answer books	<u>1</u>

Requirements:

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

No. of Pages	<u>5</u>
Department(s)	<u>Electronic Engineering</u>

1.

(a) For the circuit shown in Fig. 1:

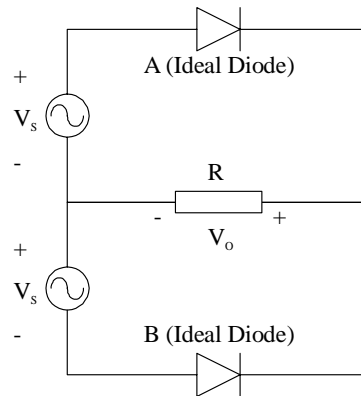


Fig. 1

- (i) Explain the two modes of operation. [2 marks]
- (ii) Sketch the output waveform V_o for a sinusoidal input waveform V_s with a peak-to-peak voltage of 7.5 V. [2 marks]
- (iii) Calculate the average DC value of V_o . [2 marks]
- (iv) Explain how V_o would change if the ideal diodes were replaced with real diodes. [1 mark]

(b) For the Zener diode voltage regulator circuit given in Fig. 2, 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). [5 marks]

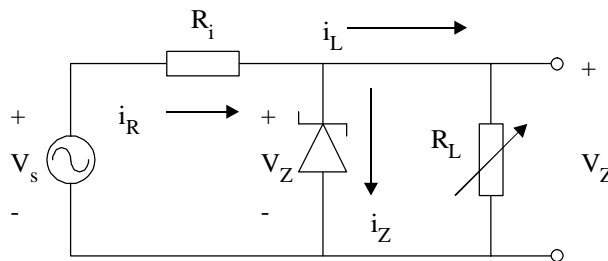


Fig. 2

(c) Write a brief description for four of the following types of diode [4 x 2 marks]:

- Germanium diode
- Schottky diode
- Varactor diode
- LED
- Flyback diode
- Photo diode

[cont'd]

2.

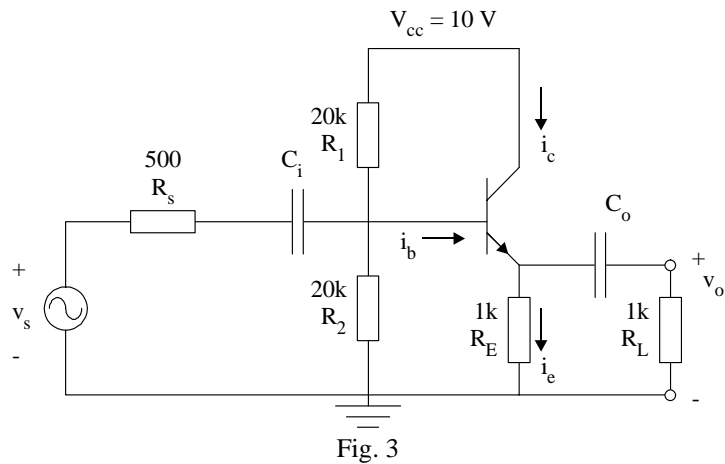


Fig. 3

(a) In the emitter follower circuit of Fig. 3, a transistor with $\beta = 100$ is used. Complete the box model by calculating the following quantities:

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

[15 marks]

(b) Draw the box model for a real buffer circuit.

[4 marks]

(c) Why would one use a common base amplifier over a common emitter amplifier?

[1 marks]

3.

(a) Draw both the hybrid-pi and the h-parameter AC models for the npn BJT, and show how they differ.

[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]

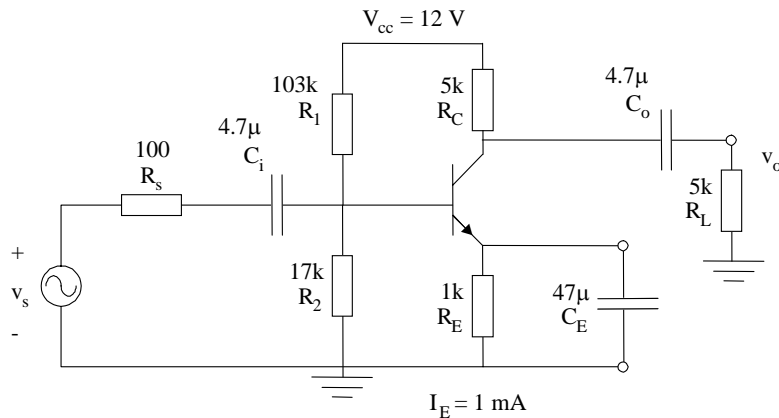


Fig. 4

[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]

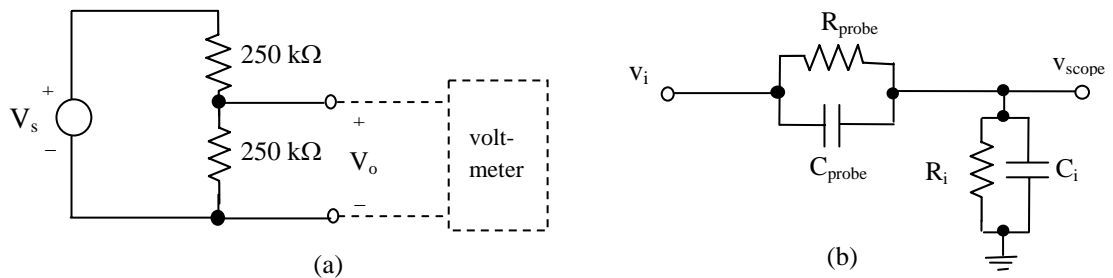


Fig. 5(a). Voltage test circuit, (b) Circuit model of oscilloscope with probe

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 .

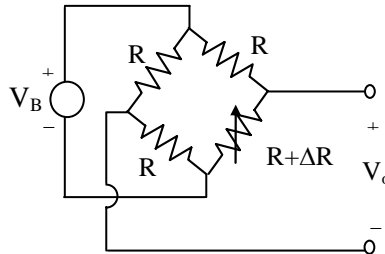


Fig. 6. Strain gauge bridge circuit

(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 $\Delta R = 3.5 \Omega$.
- (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]