GX554

Ollscoil na hÉireann, Gaillimh
National University of Ireland, Galway

SUMMER EXAMINATIONS, 1999

SECOND YEAR ELECTRONIC ENGINEERING
SECOND YEAR ELECTRONIC & COMPUTER ENGINEERING

ANALOGUE SYSTEMS DESIGN I

Professor L.E. Davis
Professor D.J. Wilcox
Dr. P. Corcoran

Duration of Examination: *Two* Hours

Instructions: Answer *all* questions in Section A
and *three* questions in Section B

Section A

(Attempt **all questions** in this section - 25 marks)

A1. The box model parameter for R_o of the CE transistor amplifier is:

a) R_b b) R_e
c) R_c d) R_a
e) R_d f) none of the above

A2. Compared to the gain of the bypassed CE amplifier the AC gain of unbypassed amplifier is:

a) almost the same b) slightly smaller
c) slightly larger d) significantly smaller
e) significantly larger f) none of the above

A3. The box model allows one to determine:

a) input resistance b) output resistance
c) input current d) voltage gain
e) all of the above f) none of the above

A4. The CE transistor amplifier operates in:

a) the linear region b) near saturation
c) in the breakdown regio d) near cut-off
e) all of the above f) none of the above

A5. A half-wave rectifier driven by a 60Hz input voltage has an output ripple frequency of:

a) 30 Hz b) 60 Hz
c) 120 Hz d) $60/\pi$ Hz
e) $\pi/60$ Hz f) none of the above

A6. A full-wave rectifier driven by a 60Hz input voltage has an output ripple frequency of:

a) 30 Hz b) 60 Hz
c) 120 Hz d) $60/\pi$ Hz
e) $\pi/60$ Hz f) none of the above

A7. A zener diode normally operates in:

a) forward biased voltage region
b) a neutral voltage region
c) reverse biased voltage region
d) at its maximum current
e) in the cut-off region
f) none of the above

A8. A 2W, 5V zener has a maximum current of:

a) 10A
b) 5A
c) 2A
d) 1A
e) 0.4A
f) none of the above

A9. If 0.7 V is measured across a 5 V zener then it is most likely that the zener is:

a) working correctly
b) short-circuited
c) open-circuited
d) in backwards
e) saturated
f) none of the above

A10. The buffer is also called a:

a) pass through amplifier
b) unity gain amplifier
c) bypass amplifier
d) zero gain amplifier
e) a stabilization amplifier
f) none of the above

A11. If all four resistors in a differential amplifier have the same value what is the gain?

a) unknown
b) -1.0
c) 1.0
d) -2.0
e) 2.0
f) none of the above

A12. In a precision rectifier the diode:

a) turn-on voltage is eliminated
b) is eliminated
c) PIV is increased
d) forward current is increased
e) power output is doubled
f) none of the above

Section B

(Attempt **3 questionsin** this section - 75 marks)

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1. **(a)** Fig 1(a).illustrates a black-box electronic circuit. There are three values of resistance available for the input imedance, Z_i: 1k, 10k and 100k. The same three values, 1k, 10k and 100k, are available for the output impedance, Z_0. The input boltage, V_i, is 10V.

   For each of the available values of input impedance calculate the input current to this circuit. If the external load, R_L, is 10k and the output voltage, V_0, is equal to the input voltage, V_i, then calculate the actual voltage at the output terminals for each of the available values of output impedance.

   [8 marks]

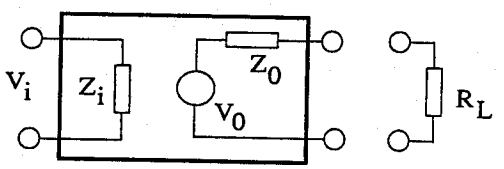

Fig 1(a): *Black Box Circuit with External Load.*

(b) The load resistor is now replaced by a second black-box, Fig 1(b). As before the same three values of input and output impedance are available. Given that *both black boxes are identical* calculate the final output voltage of this cascade circuit for all possible combinations of the available input and output impedance values without a load resistor. Then repeat when an external load, R_L, of 10k is connected across the output of the second black box.

Tabulate your results for the purposes of comparison. What conclusions can you draw from these results?

[16 marks]

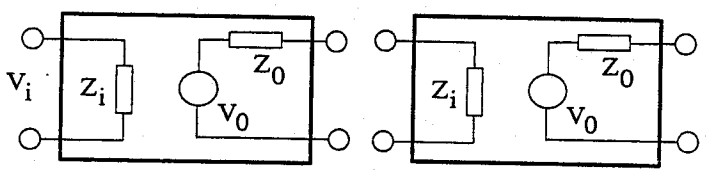

Fig 1(b): *Black Box Circuit; External Load is replaced with a second, cascaded Black Box..*

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2. (a) For the Zener power supply shown in Fig 2(a) find the current in the zener and the power dissipated in the zener for load resistances of (i) 12 kΩ., (ii) 3 kΩ, and (iii) 1 kΩ.

Assume $R_1 = 2$ kΩ and $V_{CC} = 12$ V.

[8 marks]

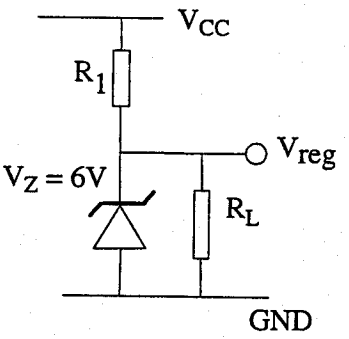

Fig 2 (a): Zener Diode Power Supply

(b) Consider the combined Transistor-Zener power supply in Fig 2(b). What is the value of Vreg?

How does this regulate the output voltage Vreg? What is the maximum output current that this power supply can source?

[Hint: Recall how the CE amplifier may be controlled using voltage biasing at the base terminal.]

[6 marks]

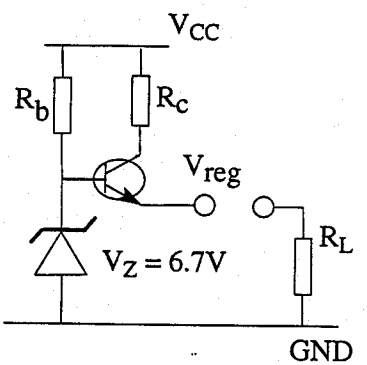

Fig 2 (b): Combination Transistor-Zener Diode Power Supply

(c) For the circuit of Fig 2(b), given that $V_{CC} = 12$ V, the power supply is required to be able to source an output current of 200 mA. Choose suitable values for R_c and R_b.

Find the current in the zener and the power dissipated in the zener for load resistances of (i) 12 kΩ., (ii) 3 kΩ, and (iii) 1 kΩ. Compare these results with those derived in part (a) of this question and comment.

[10 marks]

3. (a) A silicon BJT, h_{FE} = 50, is connected as shown in fig 3(a). Predict Ic and specify Rb to establish Vce at 2.0 V. How will Vce be affected if (i) h_{FE} = 30, (ii) h_{FE} = 100.

[8 marks]

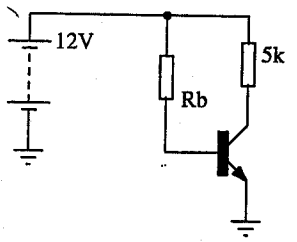

Figure 3(a): *Biasing circuit for silicon bi-polar junction [BJT] transistor*

(b) Design a common-emitter transistor amplifier with AC coupling, as shown in fig 3(b). It should operate with an AC voltage gain of 5. Assume that the current gain, β, of the transistor is approximately 100.

Include a calculation for the resistance of the base-emitter junction resistance, r_e.

[10 marks]

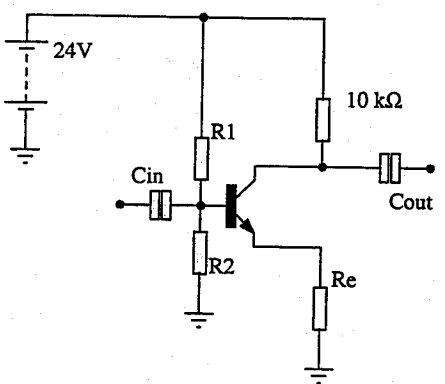

Figure 3(b): *Circuit for BJT configured as a Common-Emitter Amplifier.*

(c) By including an emitter bypass capacitor illustrate how the AC gain can be significantly increased. Calculate the the increased gain of your amplifier design and comment, briefly.

[6 marks]

4. **(a)** What are the chief characteristics of an ideal op amp? Analyse the circuit of Fig 4(a) given that the op-amp is ideal. What is the gain of this circuit?

[4 marks]

(b) What is the differential gain of the circuit in Fig 4(b) given that R3/R2 = R4/R1? Show, step-by-step, how you derived this expression for the gain and clearly state any asssumptions you make in the analysis.

[10 marks]

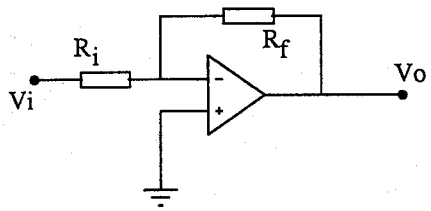

Fig 4(a): *Basic Inverting Op-Amp Circuit.*

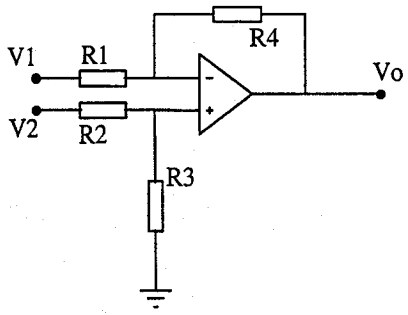

Fig 4(b): *Op-amp configured as a Differential Amplifier.*

(c) For the bridge amplifier configuration shown in Fig. 4(c) find

(i) V_o when the sensor is held at its reference temperature ($\Delta R = 0$);
(ii) ΔV_o when the probe resistance increases by ΔR;
(iii) when R = 100Ω, Vref = 10V and $\Delta R = -1\Omega/°C$ what is $\Delta V_o/°C$?

[10 marks]

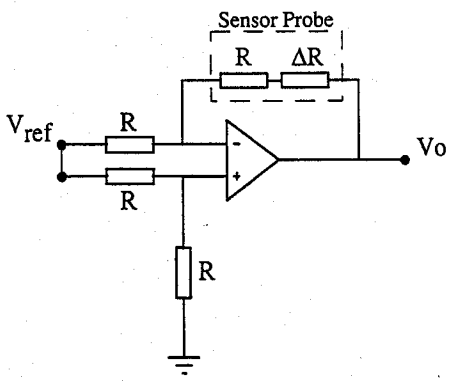

Fig 4(c): *Bridge Amplifier.*

5. (a) Sketch the circuit layout of an emitter-follower. Determine the complete box model for this buffer amplifier by calculating:

(i) total input resistance;
(ii) total output resistance;
(iii) system gain.

[14 marks]

(b) Calculate the total system gain of the amplifier shown in Fig 5. Use the complete box model to make you calculations.

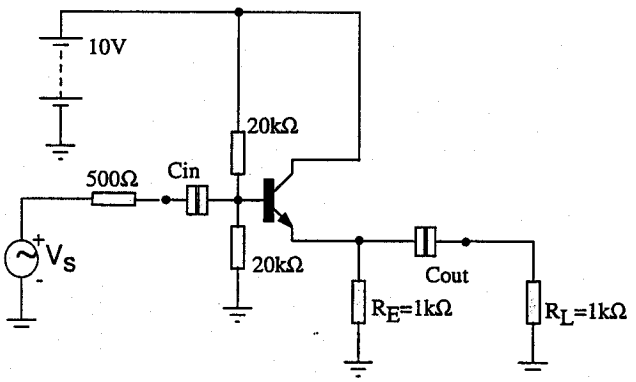

Fig 5: *Emitter Follower with Signal Generator and finite Output Resistance.*

[10 marks]