The University Of Sheffield.

DEPARTMENT OF ELECTRONIC AND ELECTRICAL ENGINEERING

January 2014 (2 hours)

EEE225 ANALOGUE AND DIGITAL ELECTRONICS MID YEAR TEST

Answer **ALL** questions. **The numbers given after each question indicate the relative weighting of that question. A total of 50 marks can be obtained from the eight questions.**

REGISTRATION NUMBER:.....

WRITE YOUR ANSWERS ON THIS QUESTION PAPER

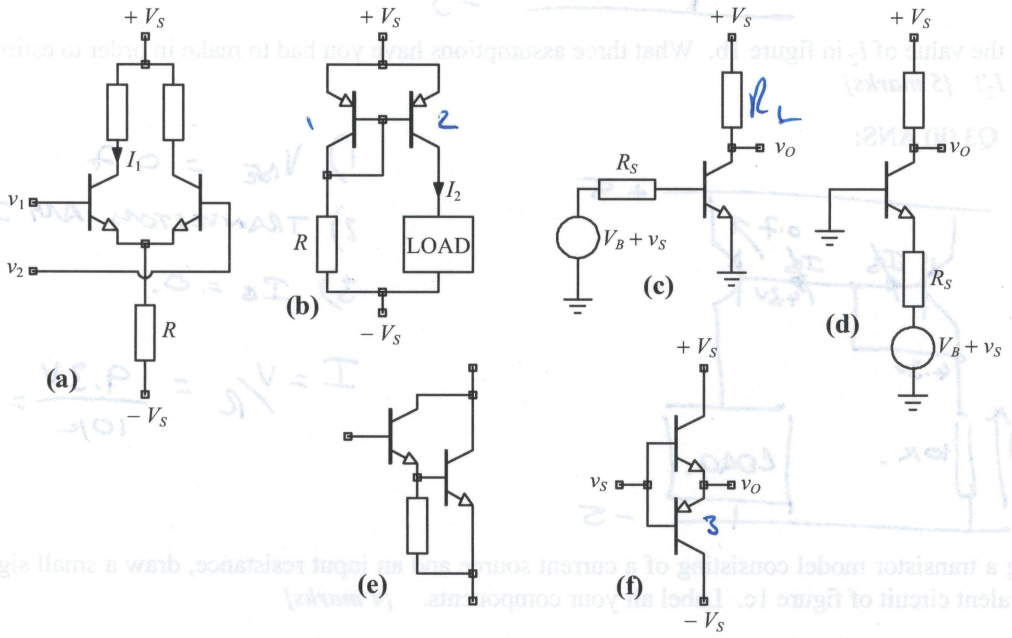


Figure 1

1 Figure 1 shows six transistor circuits. Complete the table below by identifying the circuits (a) to (f) each with one of the names in the table below. Note that there are more names than circuits. ***{6 marks}***

emitter follower		common base amplifier	D	current mirror	B
differential amplifier	A	cascode pair		voltage regulator	
push-pull output stage	F	Darlington pair	E	common emitter	C

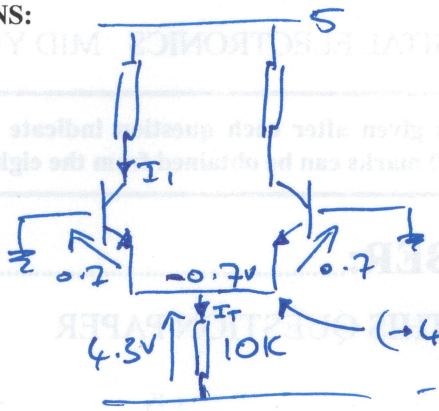
2 How many p-n-p transistors are shown in total in figure 1? *{1 mark}*

Q2 ANS: 3

3 In all the circuits of Figure 1 + $V_S = 5$ V, $-V_S = -5$ V and $R = 10$ kΩ. Estimate

(i) the value of I_1 in figure 1a when $v_1 = v_2 = 0$ V. What two assumptions have you had to make in order to estimate I_1? *{5 marks}*

Q3 (i) ANS:



1) $V_{BE} = 0.7$ V.

2) TRANSISTORS ARE SIMILAR. (IDENTICAL...)

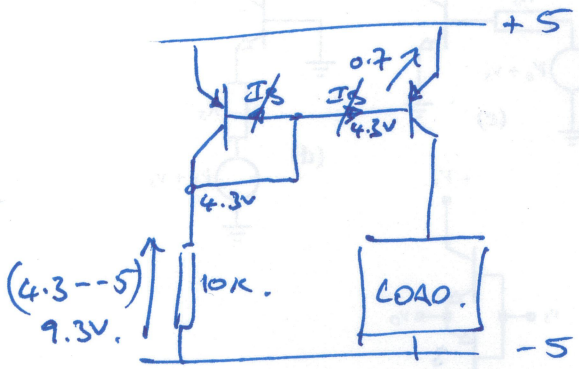
$I_T = V/R = 4.3/10K = 430\mu A$

$I_1 = I_T/2 = 215\mu A$

(→4.3V. ABOVE -5)

(ii) the value of I_2 in figure 1b. What three assumptions have you had to make in order to estimate I_2? *{5 marks}*

Q3 (ii) ANS:



1) $V_{BE} = 0.7$

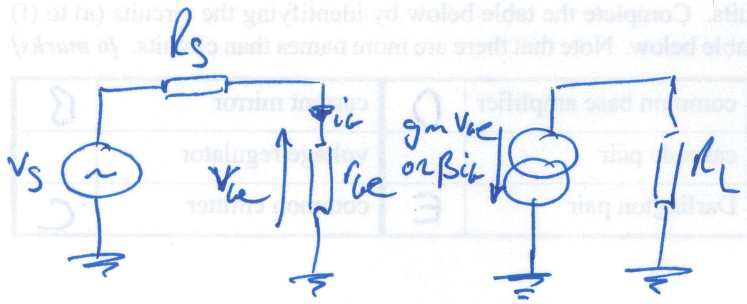
2) TRANSISTORS ARE IDENTICAL

3) $I_B = 0$.

$I = V/R = \frac{9.3V}{10K} = 980\mu A$

4 Using a transistor model consisting of a current source and an input resistance, draw a small signal equivalent circuit of figure 1c. Label all your components. *{4 marks}*

Q4 ANS:



5 The three standard forms of a first order transfer function are:

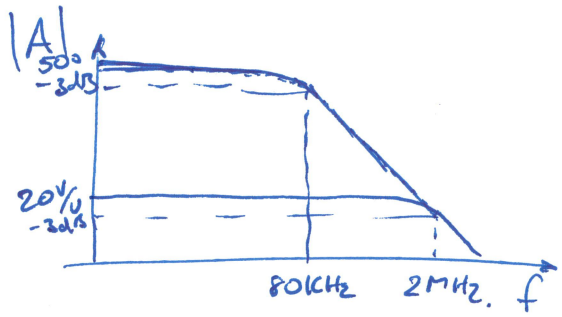
$$\textbf{(a)}\ \frac{v_o}{v_i} = k\,\frac{1}{1+j\dfrac{\omega}{\omega_0}}, \qquad \textbf{(b)}\ \frac{v_o}{v_i} = k\,\frac{j\dfrac{\omega}{\omega_0}}{1+j\dfrac{\omega}{\omega_0}} \text{ and} \qquad \textbf{(c)}\ \frac{v_o}{v_i} = k\,\frac{1+j\dfrac{\omega}{\omega_1}}{1+j\dfrac{\omega}{\omega_0}}$$

Identify the names of each of these transfer functions by putting the appropriate letter (a, b or c) against the names in the table below. There might be more than one correct answer for each transfer function. ***{4 marks}***

band stop		lead - lag	C
underdamped		all pass	
pole - zero	C	high pass	B
low pass	A	band pass	

6 An op-amp connected as a non-inverting amplifier with resistive feedback has a – 3 dB bandwidth of 2 MHz when wired to give a low frequency gain of 20 V/V. What – 3 dB bandwidth would be expected for the same amplifier if its feedback resistors were modified to give a low frequency gain of 500 V/V? ***{3 marks}***

Q6 ANS:



GBP = CONSTANT.

$20 \times 2\text{MHz} = 500 \times x\,\text{MHz}$.

$\frac{20 \times 2}{500} = 80\,\text{KHz}$.

7 A certain op-amp has a slew rate specified as 10 V μs^{-1}. What is the maximum frequency at which a 4 Vpk-pk sinusoid can be supported in undistorted form at its output? ***{3 marks}***

Q7 ANS:

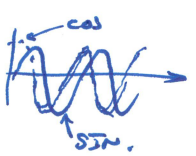
NEED TO EQUATE $V_p\omega$ TO SLEW RATE. SEE PAGE 16 OF THE NOTES ON OPAMP CIRCUITS.

$V_p\omega = 10\,V/\mu s = 2 \cdot \omega = 10 \times 10^6$

$\omega = 5 \times 10^6$

$= 795.77\,KHz$

THIS IS BECAUSE A SINE CAN BE DIFFERENTIATED TO GET ITS $\frac{dv}{dt}$ sin → cos. [STRICTLY $V_p \sin(\omega t) \rightarrow V_p\omega \cos(\omega t)$]



∴ COS IS BIGGEST AT $t = 0$ ($\cos = 1$) AND $\sin(0) = 0$ SO WHEN CROSSING THE AXIS.