ELEC50001 EE2 Circuits and Systems

Problem Sheet 2

(Operation Amplifier Applications – Lectures 3 – 4)

1. Shown in *Figure Q1a* is an output circuit that drives a resistive load. If V_{IN} is a sinewave, plot the waveform for V_{OUT}. The output driver circuit is now modified to that shown *in Figure Q1b*. Explain how this circuit works and plot the waveform for V_{OUT} for a sinusoidal input.

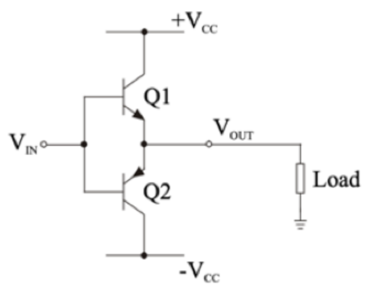

Figure Q1a

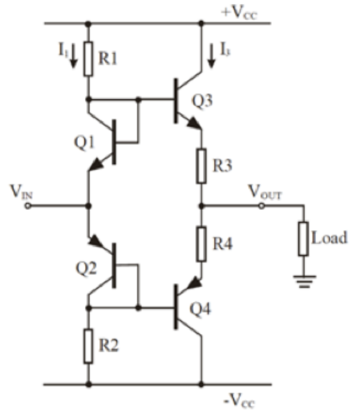

Figure Q1b

2. *Figure Q2* shows a class A amplifier circuit with Vcc = 20V. R_C is the load resistance. Assuming the current gain of the transistor Q is 25, and that input voltage Vi produces a peak based current of 10mA, calculate the input supply power, output power and efficiency of the amplifier.

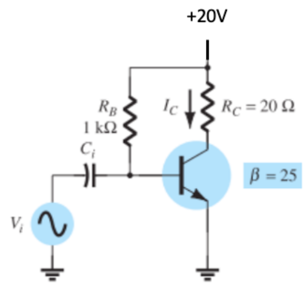

Figure Q2

3. *Figure Q3* shows a push-pull amplifier circuit with Vcc = 25V and Vss = -25V. The input signal (sinewave) is 12V rms, and the gain of the amplifier is 1. Calculate the input power, output power, and power handled by each output transistor. Hence, calculate the circuit efficiency.

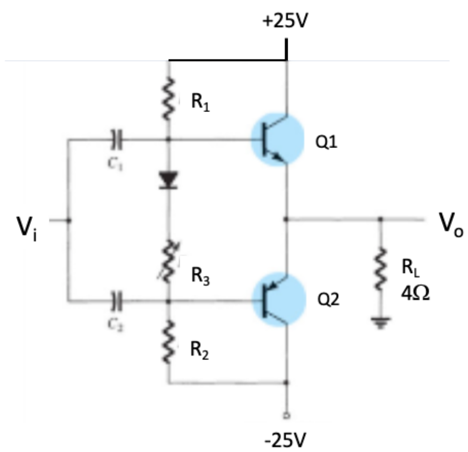

Figure Q2

4. Derive an equation for the closed-loop gain G = Y/X for the circuit shown below assuming that the open-loop gain of the op-amp is A_1 and the feedback factor is K.

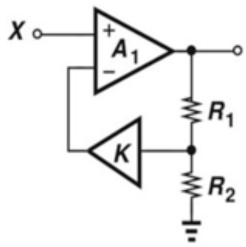

Figure Q4

5. *Figure Q5* shows two different analogue comparators with hysteresis (also known as Schmidt Trigger circuits) that compare the input voltage V_{IN} to some switching thresholds. Calculate the switching thresholds for each circuit in terms of V_{REF}, R_1 and R_2.

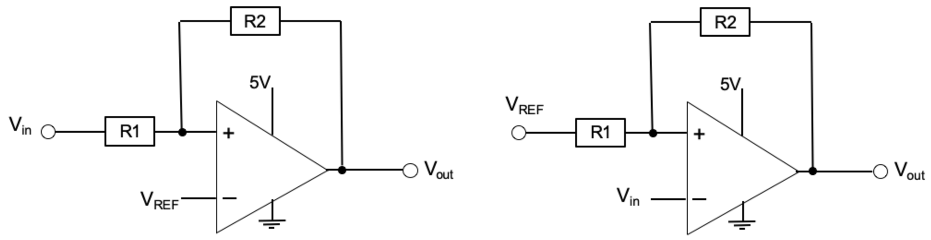

Figure Q5a *Figure Q5b*

6. *Figure Q6* shows a function generator that produces a square wave and a triangular wave. Calculate the amplitudes of and frequency of the signals.

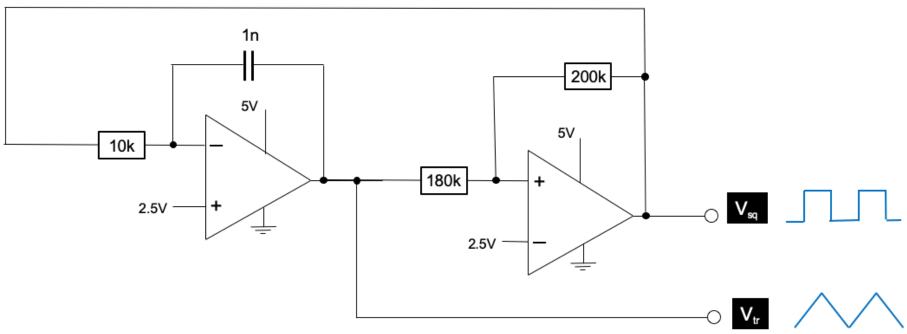

Figure Q6

7. *Figure Q7* shows Butterworth lowpass filter implemented using an op-amp. Derive an equation for the frequency response for this filter in terms of R1, R2, C1 and C2. Determine the value of R1 and R2, given that C1 and C2 are both 10nF and the corner frequency is 10kHz.

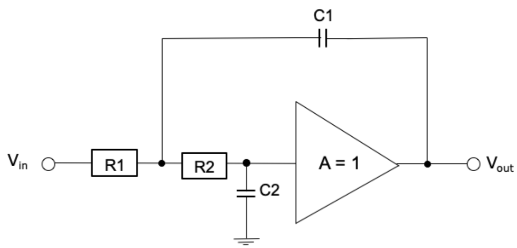

Figure Q7

8. The triangular signal from Q5 is connected the negative input of an op-amp and an analogue voltage Vin is applied to the positive input as shown in Figure Q8. Derive an equation relating to the average voltage of V_{pwm} to V_{in} and the conditions under which this equation applies. Design a circuit to extract the average voltage from V_{pwm}.

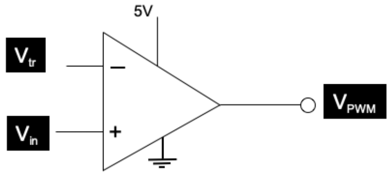

Figure Q8