ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme June 2003

GCE

Electronics

Unit ELE2

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ELE2 – Further Electronics

1 (a) Summing amplifier or mixer ✓

(1mark)

(b) Output of circuit needs to be amplified by 5 ✓

Calculation or reasoned deduction of feedback resistor changes ✓

R_f changed to 500kΩ ✓

{gain of circuit needs to be increased ✓}

{increase value of feedback resistor ✓}

(3 marks)

(c) (i) Resistor ✓

connected to inverting input terminal ✓

(2 marks)

(ii) Guitar needs to be amplified four times more than other inputs ✓

Calculation or reasoned deduction of feedback resistor changes ✓

Resistor value of 25kΩ ✓

(3 marks)

(Total 9)

2 (a) Binary value = 1111. Decimal value is 15 ✓ Hex value is F ✓

(2 marks)

(b) The three terms for the heater to be on ✓

ORed together ✓

to give expression $\mathbf{Q = D\overline{C}B\overline{A} + \overline{D}C\overline{B}A + \overline{D}\,\overline{C}\,\overline{B}A}$ ✓

(3 marks)

(c) Two steps of simplification to give $\mathbf{Q = \overline{D}\,\overline{B}A + D\overline{C}B\overline{A}}$ ✓ ✓

(2 marks)

(Total 7)

3 (a) Voltage gain = Vout / Vin = 2 / 0.02 = 100 ✓

{20mV x 100 = 2V ✓}

(1 mark)

(b) (i) P at inverting input ✓

(1 mark)

(ii) Gv = -Rf / R1 = -100 => R = 100 x 10000 ✓

=> R = 1MΩ ✓

(2 marks)

(iii) 10kΩ ✓

(1 mark)

(c) Hydrophone has a large output resistance ✓

Amplifier has a low input resistance ✓

Input to amplifier only approximately 20 x 10000 / 1010000 = 0.2mV ✓

Hydrophone internal resistance contributes to input resistance of inverting amp ✓

So giving unity gain ✓

max (2 marks)

(d) Input to + input ✓

resistor from – input to 0V ✓

feedback resistor 1MΩ and R_1 = 10kΩ (or appropriate values) ✓
{R_f must be greater than 10kΩ}

(3 marks)

(e) Very high input resistance ✓

(1 mark)
(Total 11)

4 (a) Push switch pressed, input to first NAND gate goes high ✓

Output of first NAND gate goes low, output of astable goes high ✓

Capacitor discharges and charges in opposite direction ✓

Until voltage at input to first NAND gate $<+V_s/2$ ✓

Output of astable switches state ✓

Capacitor charges in opposite direction ✓

Process repeats as long as switch pressed ✓

max (5 marks)

(b) $$\mathbf{f = \frac{1}{2RC} = \frac{1}{2 \times 10^4 \times 10^{-7}} = 500Hz}$$ ✓ ✓

(2 marks)

(c) (i) On the rising edge of each clock pulse ✓

the output of the D-type flip-flop changes state ✓

(2 marks)

(ii) They flash {alternately so fast that they appear to be continuously lit} ✓

(1 mark)
(Total 10)

5 (a) $X_c = 1/2 \times \pi \times 200 \times 15 \times 10^{-9}$ ✓
X_c = 53kΩ ✓

(2 marks)

(b) Use of non-inverting amplifier formula ✓

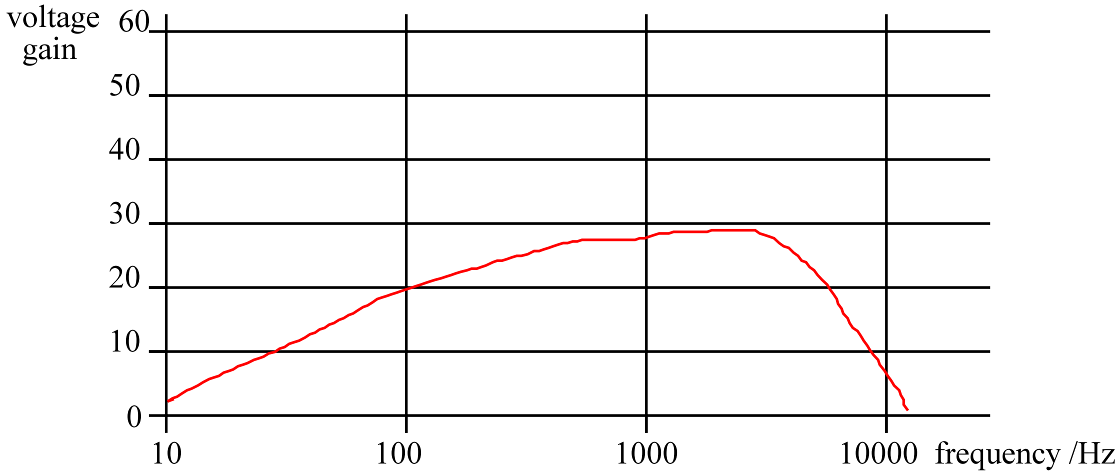
If effect of capacitors ignored gain =58 ✓

If effect of capacitors taken into account ✓

Gain around 30 ✓

max (5 marks)

(c)



One mark for low freq., one for mid range, one for high freq. ✓ ✓ ✓

Graph should agree with calculated values for three marks

(3 marks)

(Total 8)

6 (a) Falling edge of clock pulse ✓

{when its output is low ✓}

(1 mark)

(b) (i) Negative going pulse makes output of gate A go high, ✓

This makes input of gate B high, and output low, ✓

Capacitor charges through thermistor, ✓

Until voltage at input of gate B is below half of the supply voltage, ✓

Output of gate B goes high, output of gate 3 low ✓

Monostable resets. ✓

max (5 marks)

(c) (i) $T = CR = 10^{-8} \times 180 \times 10^{3}$ ✓ $= 1.8$ms

(1 mark)

(ii) $T = CR = 10^{-8} \times 10^{4} = 0.1$ms ✓

(1 mark)

(d) The astable triggers the monostable every 2ms and so when cold the monostable provides an almost continuous output to the driver so keeping the heater switched on. ✓

When the thermistor warms up the output from the monostable is shorter and so the heater is on for less time in every 2ms. ✓

A temperature will be reached where the length of time that the heater is switched on is just sufficient to maintain the temperature of the thermistor ✓

max (2 marks)

(Total 9)

7 (a) Volume control ✓

{allows adjustment of the effect of the input ✓}

(1 mark)

(b) (i) assumption e.g. MOSFETs need V_{gs} of 2V ✓

11 - 15V ✓

(2 marks)

(ii) Voltage gain of source follower is 1 ✓

Inverting amp - gain of -15 ✓

(2 marks)

(c) (i) Cross-over distortion ✓

(1 mark)

(ii) Bias the MOSFETs into conduction ✓

by applying permanent bias voltage to gate ✓

Use negative feedback ✓

by incorporating output devices into op-amp feedback loop ✓

(4 marks)

(iii) Only a noise/sound is needed ✓

(1 mark)

(d) (i) $W = I^2 \times R = 2.3^2 \times 4 = 21W$ ✓ ✓

(2 marks)

(ii) {Difference between input power and output} power is dissipated as heat in MOSFETs ✓

Heatsinks prevent MOSFETs from being destroyed by getting too hot ✓

(2 marks)

(e) Metal - good conduction of heat away from MOSFETs ✓

Large surface area - good convection and radiation of heat from MOSFETs ✓

Matt black - good radiation of heat from MOSFETs ✓

Good thermal contact with MOSFETs ✓

Fan to improve air circulation ✓

max (3 marks)

(Total 18)

(Paper Total 72 marks)