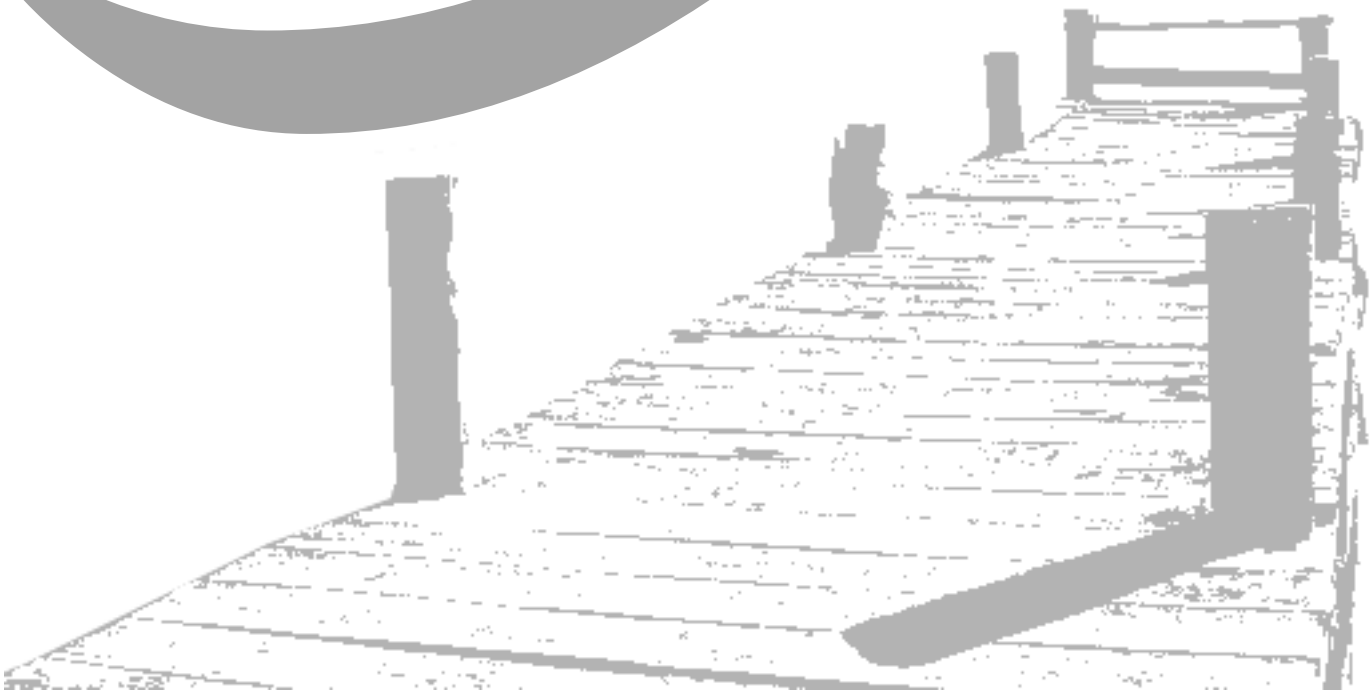
GCE
AS and A Level

Electronics

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 2: ELEC2
Further Electronics

Version 1.1



Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature									

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General Certificate of Education
Advanced Subsidiary Examination
version 0.2

ASSESSMENT and QUALIFICATIONS ALLIANCE

ELECTRONICS ELEC2
Unit 2 Further Electronics

SPECIMEN PAPER

For this paper you must have:
- a pencil and a ruler
- a calculator.

Time allowed: 1 hour

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the space provided.
- Show the working of your calculations.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- A *Data Sheet* is provided on pages 3 and 4. Detach this perforated sheet at the start of the examination.

Information
- The maximum mark for this paper is 67.
- The marks for the questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- Any correct electronics solution will gain credit.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use			
Number	Mark	Number	Mark
1		5	
2		6	
3		7	
4			
Total (Column 1)			
Total (Column 2) →			
TOTAL →			
Examiner's Initials			

Data Sheet

- A perforated *Data Sheet* is provided on pages 3 and 4 of this question paper.
- This sheet may be useful for answering some of the questions in the examination.
- Detach this perforated sheet at the start of the examination.

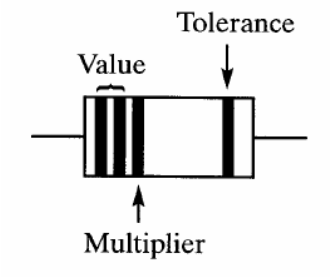
Data Sheet

Resistors Preferred values for resistors (E24) series:
1.0, 1.1, 1.2, 1.3, 1.5, 1.6, 1.8, 2.0, 2.2, 2.4, 2.7, 3.0, 3.3, 3.6, 3.9, 4.3, 4.7, 5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1 ohms and multiples that are ten times greater

Resistor Printed Code (BS 1852) This code consists of letters and numbers:
R means × 1
K means × 1000 (i.e. 10^3)
M means × 1 000 000 (i.e. 10^6)
Position of the letter gives the decimal point
Tolerances are given by the letter at the end of the code,
F = ± 1%, G = ± 2%, J = ± 5%, K = ± 10%, M = ± 20%.

Resistor Colour Code

Number	Colour
0	Black
1	Brown
2	Red
3	Orange
4	Yellow
5	Green
6	Blue
7	Violet
8	Grey
9	White



Tolerance, gold = ±5%, silver = ±10%, no band = ±20%

Silicon diode $V_F = 0.7$ V

Silicon transistor $V_{be} \approx 0.7$ V in the on state, $V_{ce} \approx 0.2$ V when saturated

Resistance

$R_T = R_1 + R_2 + R_3$ series

$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ parallel

Capacitance

$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$ series

$C = C_1 + C_2 + C_3$ parallel

Time constant $T = CR$, $T_{½} = 0.69\,CR$

ac theory

$I_{rms} = \frac{I_0}{\sqrt{2}}$

$V_{rms} = \frac{V_0}{\sqrt{2}}$

$X_C = \frac{1}{2\pi fC}$ reactance

$X_L = 2\pi fL$ reactance

$f = \frac{1}{T}$ frequency, period

$f_0 = \frac{1}{2\pi\sqrt{LC}}$ resonant frequency

Turn over ▸

Operational amplifier	$G_V = \frac{V_{out}}{V_{in}}$	voltage gain
	$G_V = -\frac{R_f}{R_1}$	inverting
	$G_V = 1 + \frac{R_f}{R_1}$	non-inverting
	$V_{out} = -R_f\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$	summing
	$V_{out} = (V_+ - V_-)\ \frac{R_f}{R_1}$	difference
555 Astable and Monstable	$T = 1.1RC$	monostable
	$t_H = 0.7\ (R_A + R_B)C$ $t_L = 0.7\ R_B C$	astable
	$f = \frac{1.44}{(R_A + 2R_B)C}$	astable frequency
Electromagnetic waves	$c = 3 \times 10^8$ m s^{-1}	speed in vacuo

Assembler language microcontroller instructions

Mnemonic	Operands	Description	Operation	Flags	Clock cycles
NOP	none	No operation	none	none	1
CALL	K	Call subroutine	stack <=PC PC <=K	none	2
RET	none	Return from subroutine	PC <= stack	none	2
INC	R	Increments the contents of R	(R) <= (R) + 1	Z	1
DEC	R	Decrements the contents of R	(R) <= (R) – 1	Z	1
ADDW	K	Add K to W	W <= W + K	Z, C	1
ANDW	K	AND K with W	W <= W • K	Z, C	1
SUBW	K	Subtract K from W	W <= W – K	Z, C	1
ORW	K	OR K and W	W <= W + K	Z, C	1
XORW	K	XOR K and W	W <= W ⊕ K	Z, C	1
JMP	K	Jump to K (GOTO)	PC <= K	none	2
MOVWR	R	Move W to the contents of R	(R) <= W	Z	1
MOVW	K, W	Move K to W	W <= K	Z	1
MOVRW	R	Move the contents of R to W	W <= (R)	Z	1

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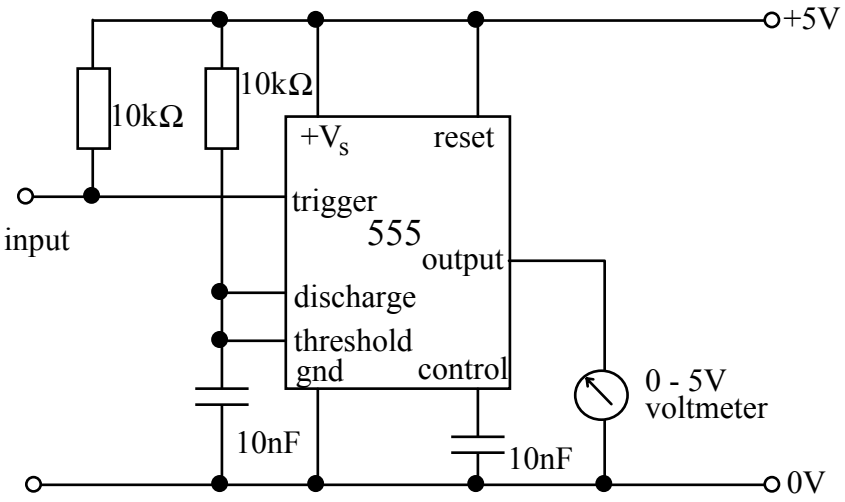
Answer **all** questions in the spaces provided.

1 Part of the circuit diagram for a simple frequency meter using a monostable is shown below.



1 (a) What type of signal is required to trigger the monostable?

……

……

(*2 marks*)

1 (b) Explain how the monostable circuit functions once it has been triggered.

……

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……

……

……

(*5 marks*)

1 (c) Calculate the time period of the monostable.

……

……

(*2 marks*)

9

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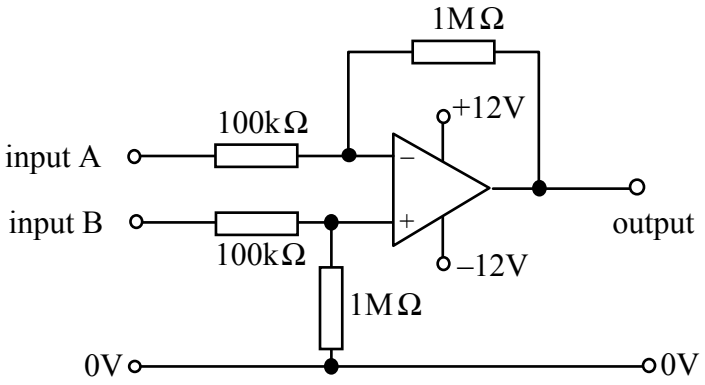
2 An audio mixing desk contains a difference amplifier. The circuit diagram is shown below.



2 (a) Calculate the differential voltage gain of this circuit.

……

……

……

(*3 marks*)

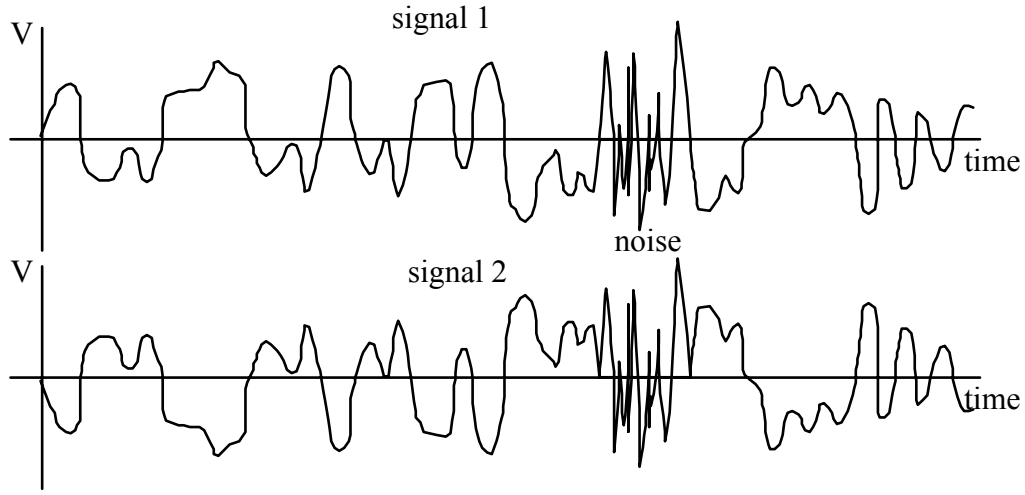
2 (b) If input B is connected to 0 V and an audio signal of 200 mV amplitude is connected to input A, calculate the amplitude of the output signal.

……

……

(*2 marks*)

2 (c) A microphone gives two audio signal outputs with respect to 0V. Signal 2 is inverted compared to signal 1. The signals received at the far end of a long cable carrying the microphone signal are shown below.



Signal 1 is connected to input A of the difference amplifier and signal 2 is connected to input B.
Explain how this arrangement is able to significantly reduce the effect on the microphone signal of noise picked up by the long cable.

……

……

……

……

……

(*4 marks*)

9

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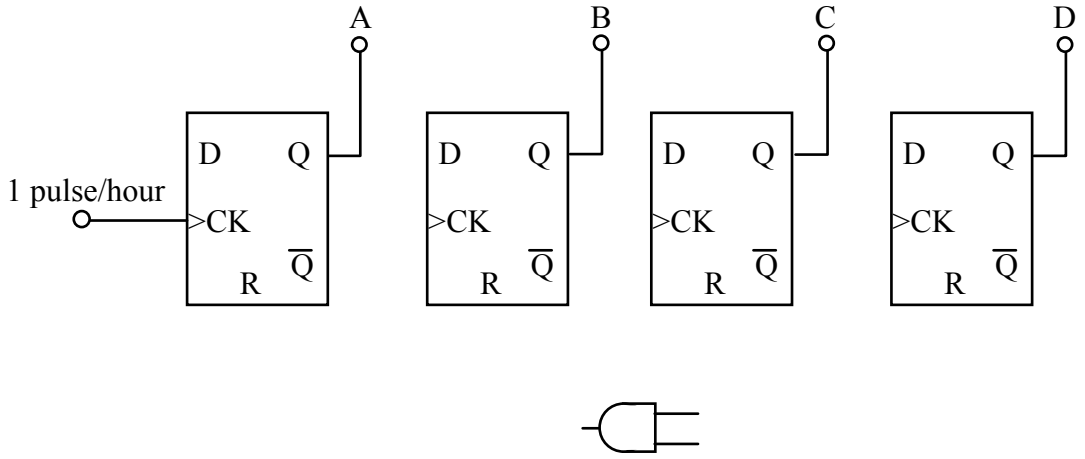
3 (a) An industrial process takes 12 hours. Complete the diagram below to show how the four D-type flip-flops can be connected to form a binary up counter which resets at 12.



(*5 marks*)

3 (b) The counter circuit above is required to turn on a heater during the first, second, third, tenth and last hour of the process.
Complete the last line of the truth table below to show the output states of the flip-flops.

Hours	**D**	**C**	**B**	**A**
first	0	0	0	0
second	0	0	0	1
third	0	0	1	0
. . . . .	. . . . .	. . . . .	. . . . .	. . . . .
tenth	1	0	1	0
last	1			1

(*4 marks*)

9

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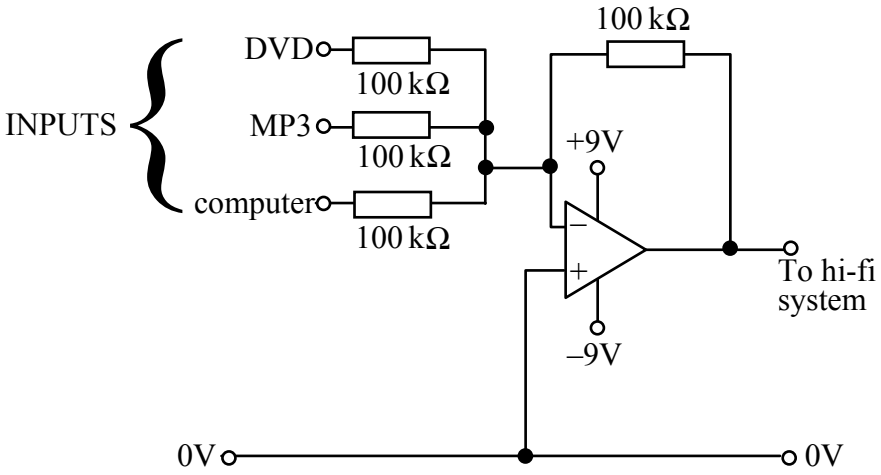
4 A student has a hi-fi system which has one input socket with which to connect other sound devices. She wants to be able to connect her computer, a portable MP3 player and a DVD player. To overcome this problem she builds the circuit shown below.



4 (a) What is the function of this circuit? ……

(*1 mark*)

The hi-fi system needs an input of 1 V, but the circuit above only gives 200 mV.

4 (b) (i) What voltage gain is required by this circuit?

……

4 (b) (ii) What change should be made to the feedback resistor to achieve this?

……

……

(*3 marks*)

With this problem solved, she decides that she needs yet another input to which she could connect an electric guitar. The peak output from the guitar is 50 mV.

4 (c) (i) Mark onto the diagram where this additional input should be connected along with the additional component that is needed.

4 (c) (ii) Calculate a suitable value for the additional component that is needed.

……

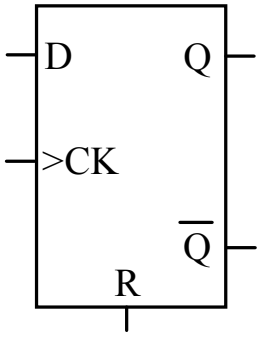
……

(*5 marks*)

9

Turn over ▸

5 A diagram of a D-type flip-flop is shown below.



5 (a) Describe the function of a D-type flip-flop.

……

……

……

……

(*2 marks*)

Four rising edge triggered D-type flip-flops are connected to form a shift register.

5 (b) Describe the function of a shift register.

……

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……

……

(*3 marks*)

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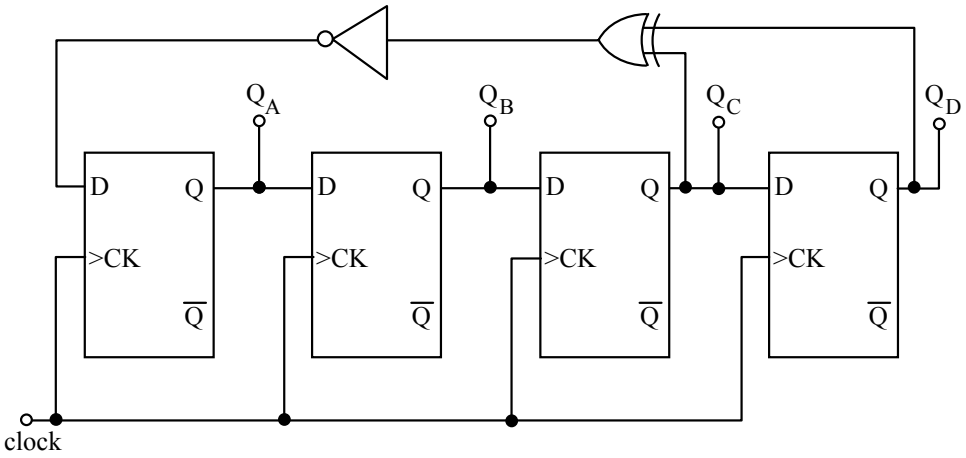
5 (c) The circuit diagram below shows a four bit pseudo-random number generator.



Outputs Q_C and Q_D are EX-ORed together, inverted and then the output is connected to the D input of the first flip-flop. The truth table for the circuit is shown below, complete the missing line.

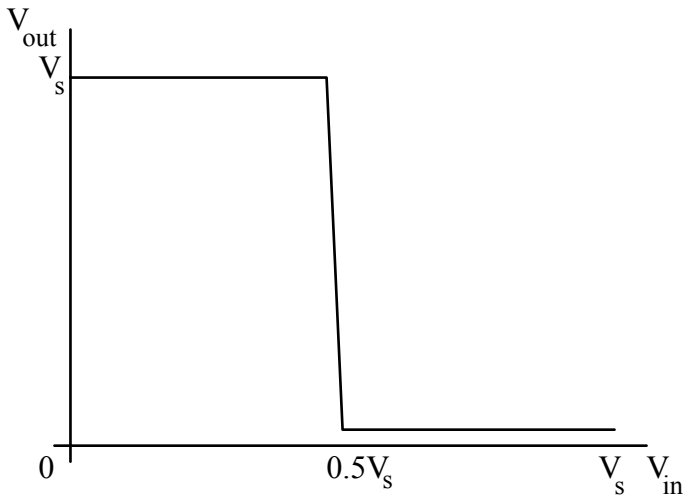
Q_A	Q_B	Q_C	Q_D	D input of first flip-flop
0	0	0	0	1
1	0	0	0	1
1	1	0	0	1
1	1	1	0	0
1	0	1	1	1

(*4 marks*)

9

Turn over for next question

6 A graph showing how the output voltage, V_{out}, of a NOT gate varies with its input voltage, V_{in}, is shown below.

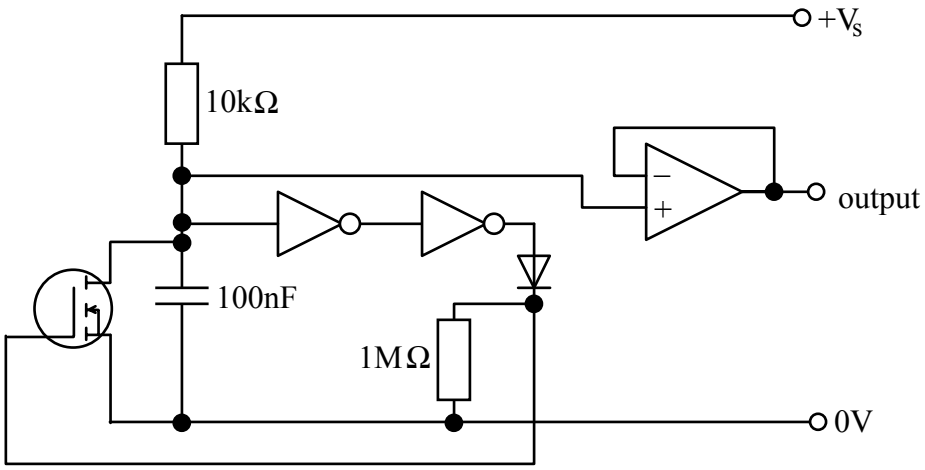


6 (a) What range of input voltages makes the output of the NOT gate logic 1?

……

(*1 mark*)

6 (b) The NOT gate is used in the circuit below to make an oscillator.



Calculate the time taken for the 100 nF capacitor to charge through the 10kΩ resistor to half of the supply voltage.

……

……

(*2 marks*)

6 (c) (i) What is the function of the op-amp?

……

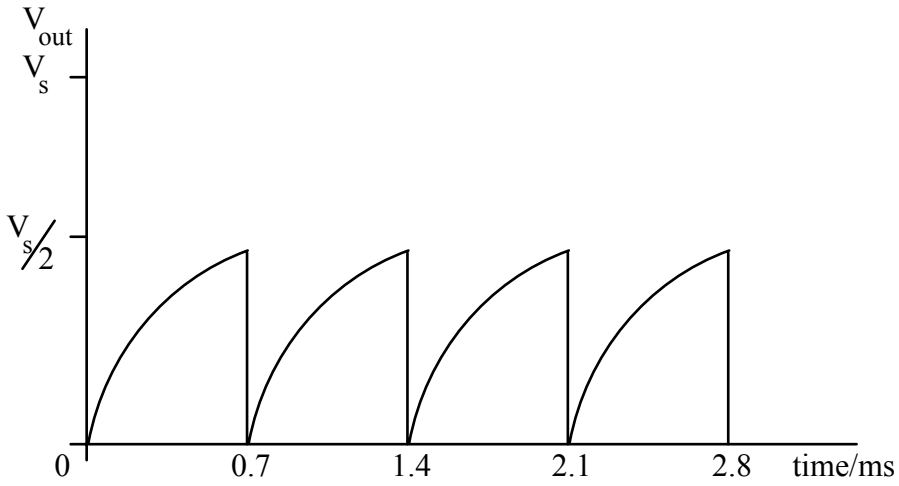
6 (c) (ii) Why is it needed in this application?

……

……

(*2 marks*)

The output waveform is shown below.



6 (d) (i) Explain why the period of the waveform is approximately 0.7ms.

……

……

6 (d) (ii) Explain why the waveform has this shape.

……

……

(*4 marks*)

9

Turn over ▸

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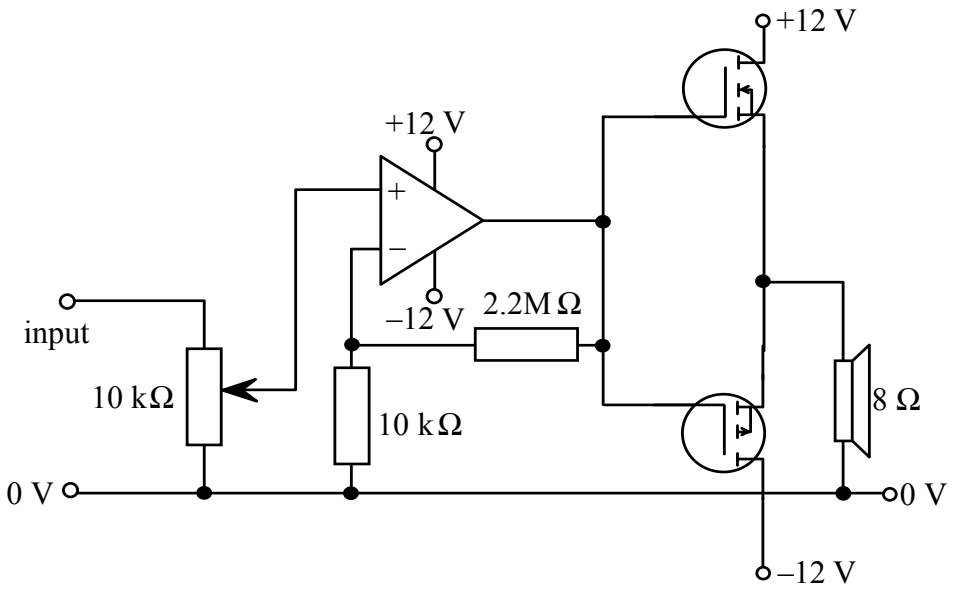
7 A student builds a guitar practice amplifier using the circuit diagram shown below.



7 (a) Assuming that the voltage gain of the source followers is 1, show that the maximum voltage gain of the circuit is 221.

……

……

(*2 marks*)

7 (b) Estimate the bandwidth of the amplifier if the voltage gain-bandwidth product of the op-amp is 10^6.

……

……

(*2 marks*)

An electric guitar has a maximum output of 120 mV.
When connected to the amplifier above the sound quality is disappointing.
When the amplifier is used with headphones at very low volume, the sound is very distorted.

7 (c) (i) What is the name given to distortion at low volume for this type of amplifier?

……

7 (c) (ii) How can this distortion can be reduced?

……

……

……

(*3 marks*)

7 (d) The student modifies the amplifier to correct for this low volume distortion, but now finds that as the volume control is turned towards maximum, the sound is harsh and distorted.
By considering the maximum output from the guitar and the maximum voltage gain of the amplifier, explain why this occurs.

……

……

……

(*3 marks*)

7 (e) Estimate the maximum undistorted output power that can be obtained from this amplifier.

……

……

……

(*3 marks*)

13

END OF QUESTIONS

There are no questions on this page