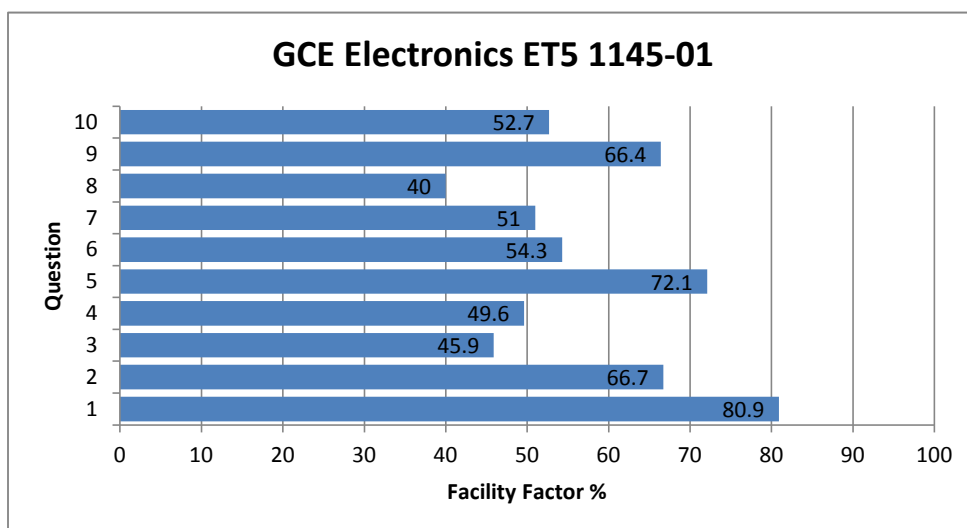


GCE Electronics ET5 1145-01

All Candidates' performance across questions

Question Title	N	Mean	SD	Max Mark	FF	Attempt %
1	404	4.9	1.3	6	80.9	100
2	404	4	2.3	6	66.7	100
3	404	3.7	2.4	8	45.9	100
4	403	4	2.8	8	49.6	99.8
5	403	3.6	1.3	5	72.1	99.8
6	402	3.8	2	7	54.3	99.5
7	403	4.1	2.7	8	51	99.8
8	403	2.4	1.9	6	40	99.8
9	403	7.3	3.1	11	66.4	99.8
10	403	2.6	1.8	5	52.7	99.8



2. The following Boolean expressions control a sequence generator:

$$D_C = \bar{B}$$

$$D_B = A \oplus C$$

$$D_A = \overline{B + C}$$

- (a) Complete the table for **all eight** possible output combinations for this sequence generator. [3]

Current Outputs				Next Outputs		
State	C	B	A	D _C	D _B	D _A
0	0	0	0			
1						
2						
3						
4						
5						
6						
7						

- (b) Write down all of the unused states. [2]

.....

.....

.....

- (c) Are there any stuck states? If so, identify them. [1]

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$$D_C = \bar{B} \quad \text{bit 0}$$

$$D_B = A \oplus C \quad \text{A and C are different}$$

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Current Outputs				Next Outputs		
State	C	B	A	D_C	D_B	D_A
0	0	0	0	1	0	1
1	1	0	1	1	0	0
2	1	0	0	1	1	0
3	1	1	0	0	1	0
4	0	1	0	0	0	0
5	0	0	1	1	1	1
6	1	1	1	0	0	0
7	0	1	1	0	1	0

Main
Seq

- (b) Write down all of the unused states. [2]

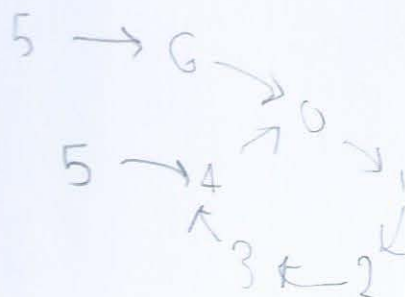
$S_5: 001$

$S_6: 111$

$S_7: 011$

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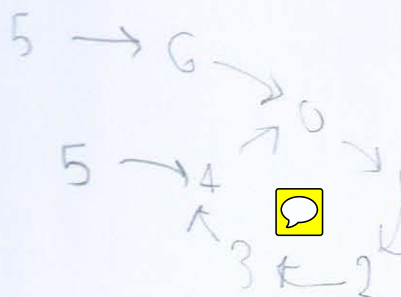
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$\bar{B} \cdot \bar{C}$

$B + C$

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01	1	0
10	1	0
11	1	0

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000
001
010
011
110
100
101

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5	1	1	1	0	1	1
6	1	0	1	0	1	0
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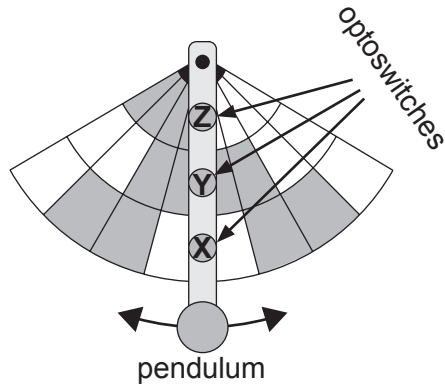
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7

5. A Gray code encoded disc is used as part of a system to warn a 4 x 4 off-road enthusiast when the vehicle has tipped to a dangerous angle. As the vehicle tips, the pendulum swings, taking the optoswitches over different segments of the encoded disc.



- (a) (i) What is the difference between Gray code and binary code?

[1]

.....

.....

.....

.....

- (ii) What is the disadvantage of using binary code rather than Gray code in this application?

[1]

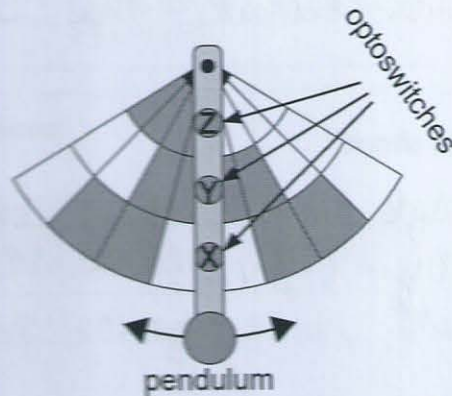
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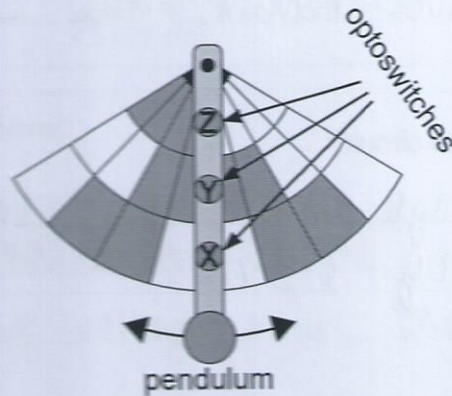
- (a) (i) What is the difference between Gray code and binary code? [1]


In gray code, only 1 bit changes at a time, whereas as in binary, multiple bits may change at ^{the same} time.

- (ii) What is the disadvantage of using binary code rather than Gray code in this application? [1]

As a result of multiple bits changing at a time, false readings can occur. This is because the optoswitches, as seen above, don't read the next set of bits at the same time, as in the example, Z reads its data bit before X does.


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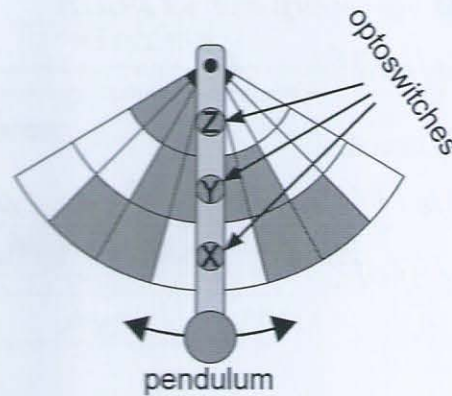
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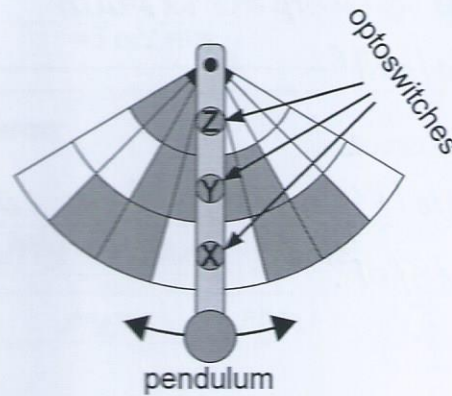
Only one bit changes in each gray code ~~step~~ increment to the count. Unlike binary where multiple bits change when the count is incremented.

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If binary ^{was} ~~there~~ to be used there would be errors where the opto-switches read part of one value and part of another during rotation.

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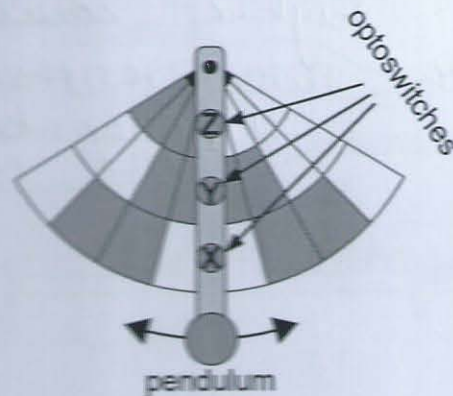
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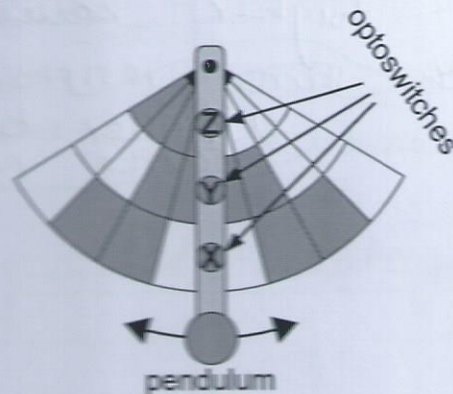
Gray code is done with colours to recognise instructions whereas binary is done with 0's and 1's in the place. Gray code offers different uses.


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It is harder to recognise 0's and 1's when there are white and gray squares to tell you if there is a hazard. Also you cannot measure how far the car has tipped with binary but it's easy with numbers of gray and white squares.


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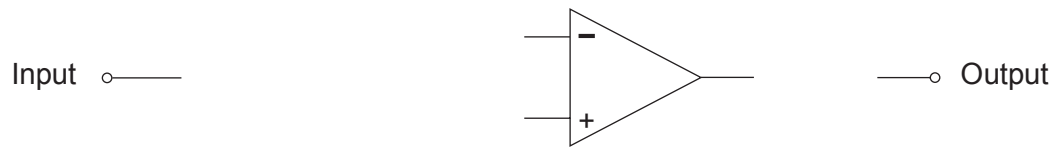
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- (b) (i) Design a filter with these characteristics, incorporating an op-amp, a $7.5\text{ k}\Omega$ resistor, a $150\text{ k}\Omega$ resistor and a capacitor. Complete the following template with your design. [3]



0V

- (ii) Which of these capacitors offers a break frequency closest to 10 kHz ? (Justify your choice with a calculation.) [2]

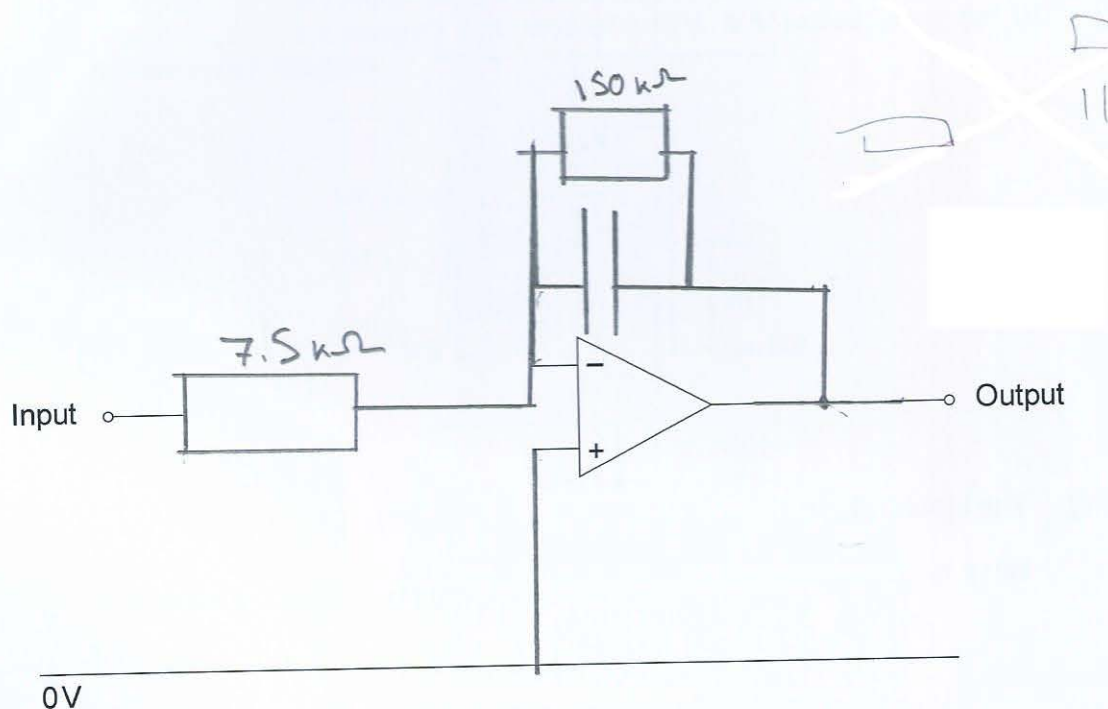
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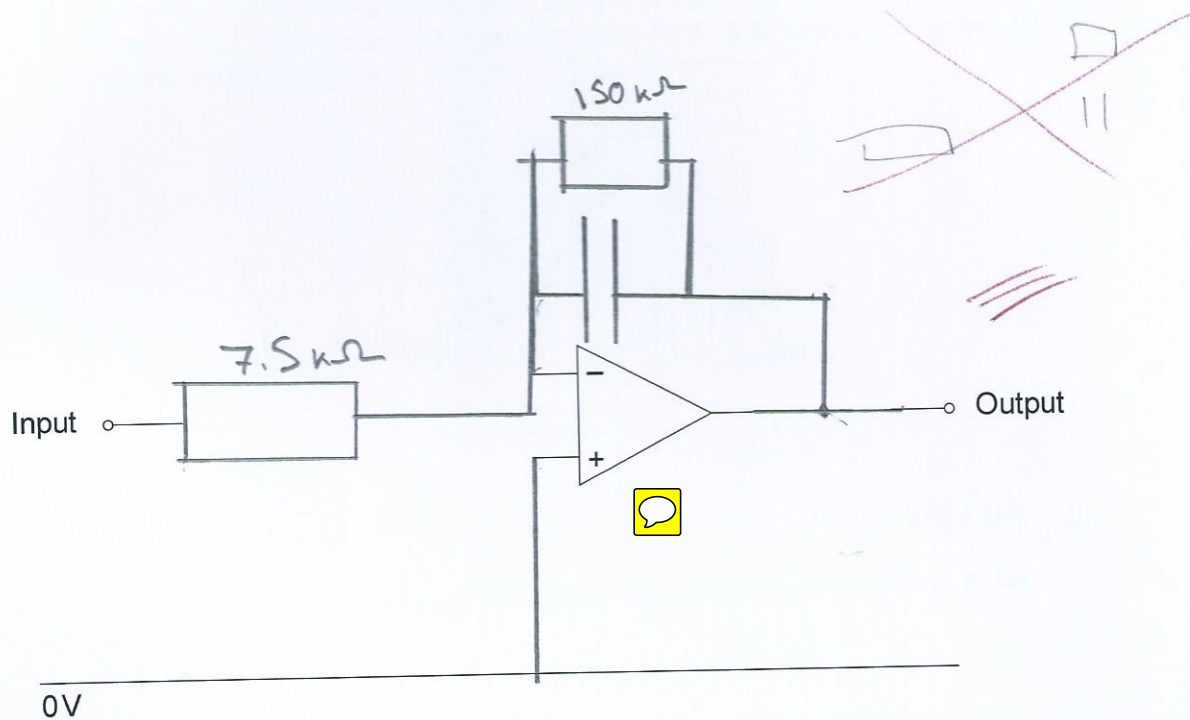
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$$f_c = \frac{1}{2\pi RC} = \frac{1}{2\pi \times (150 \times 10^3) \times (0.1 \times 10^{-9})}$$

$$= 10,600\text{ Hz} \approx 10\text{ kHz}$$

\therefore 0.1 nF capacitor.

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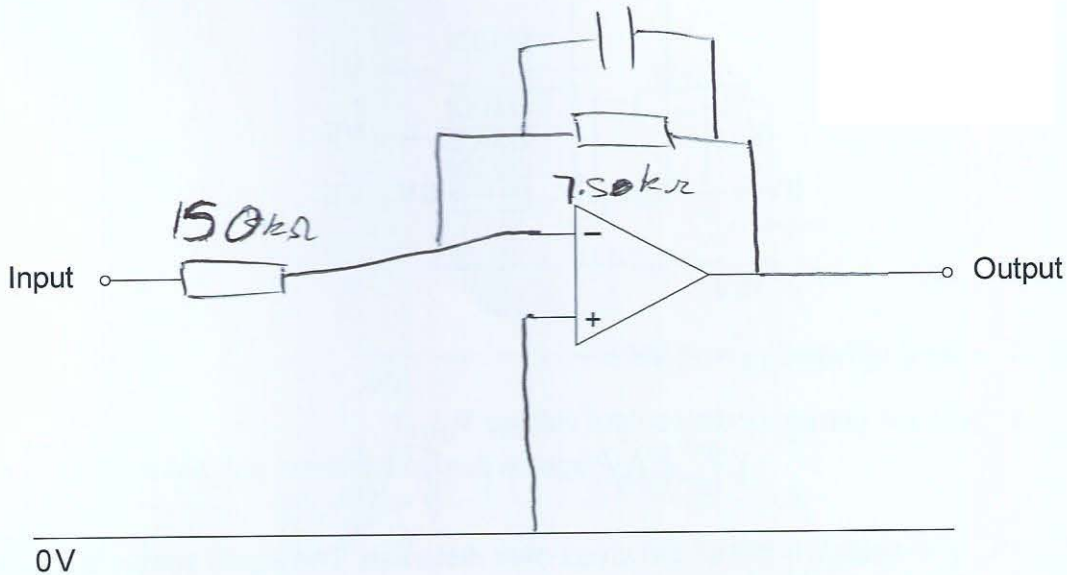
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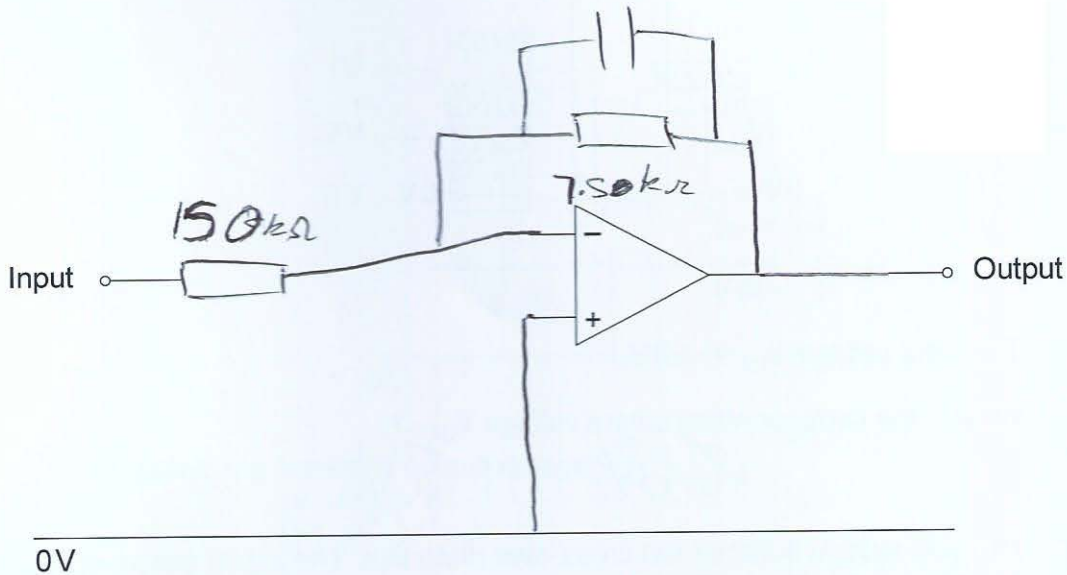


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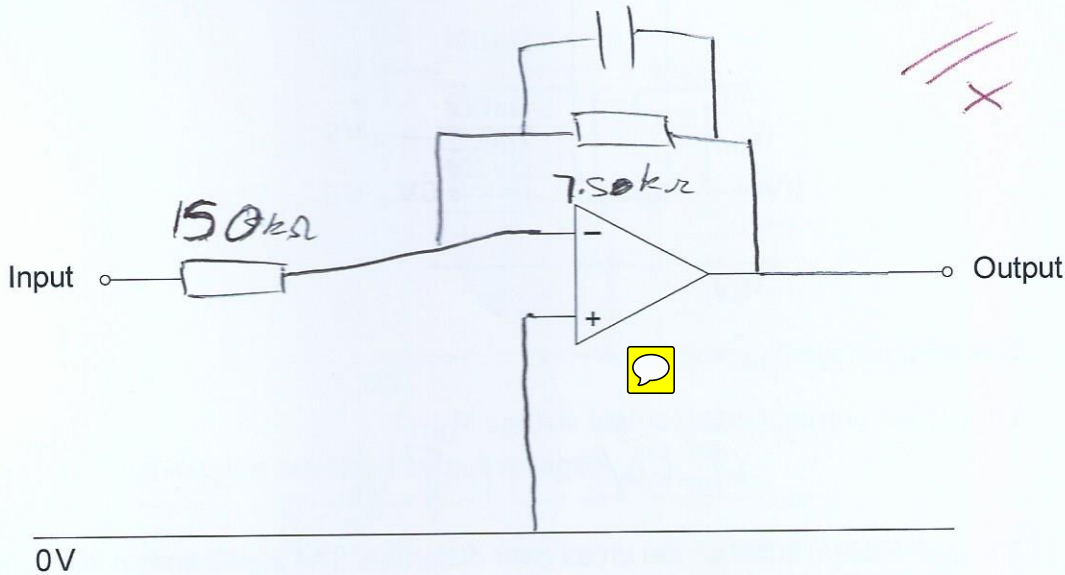


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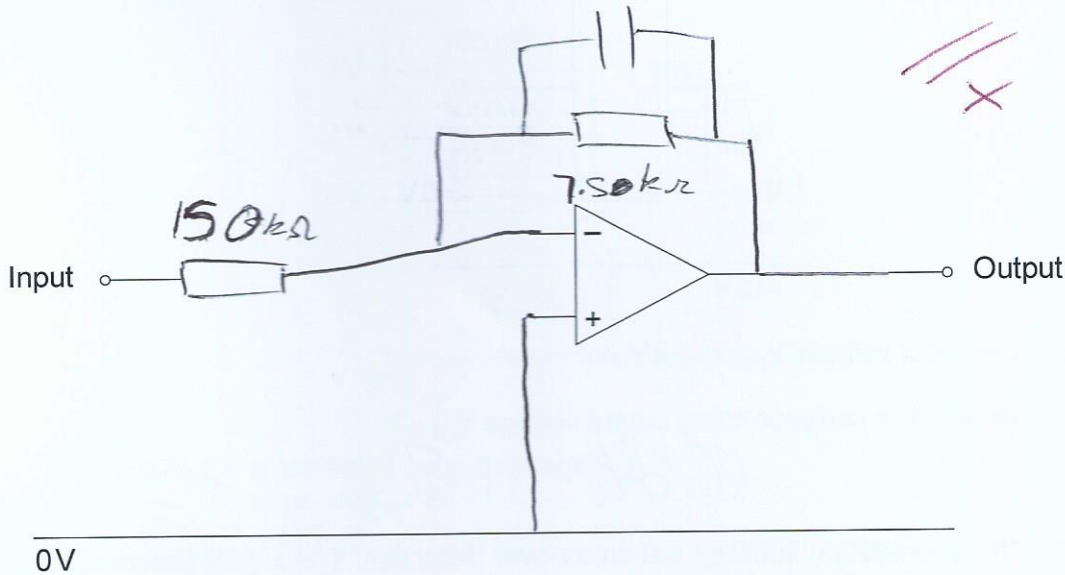
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Handwritten calculations showing the derivation of the capacitor value $C = 2\text{ nF}$ from the break frequency 10 kHz and the feedback resistor $7.5\text{ k}\Omega$.

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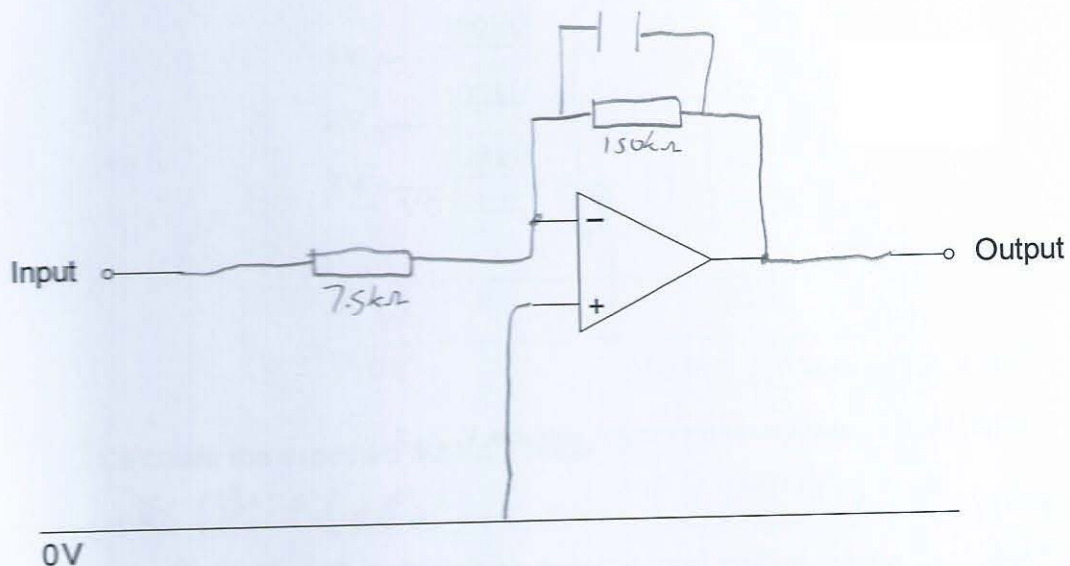


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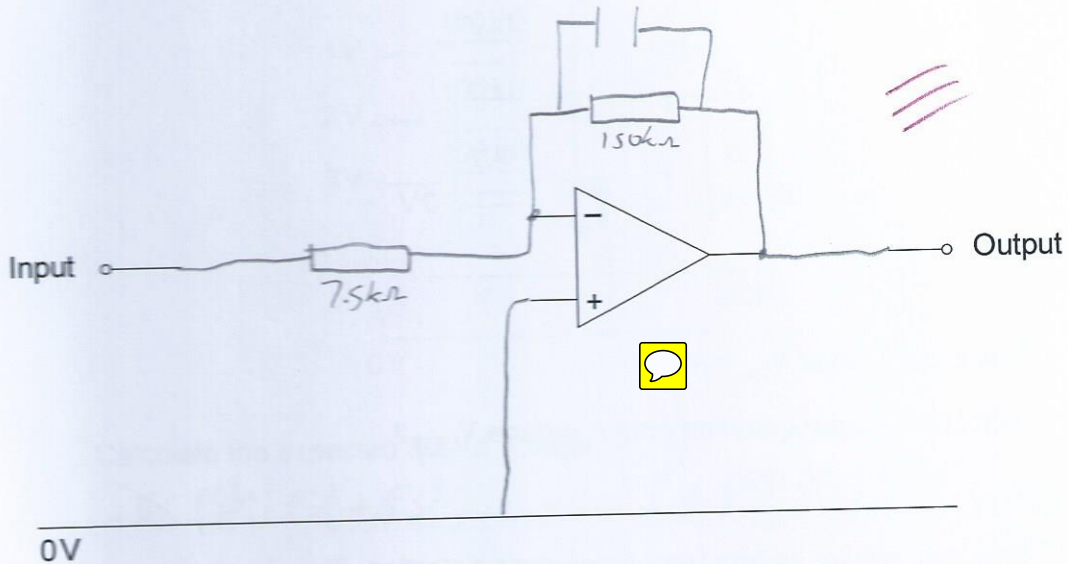


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