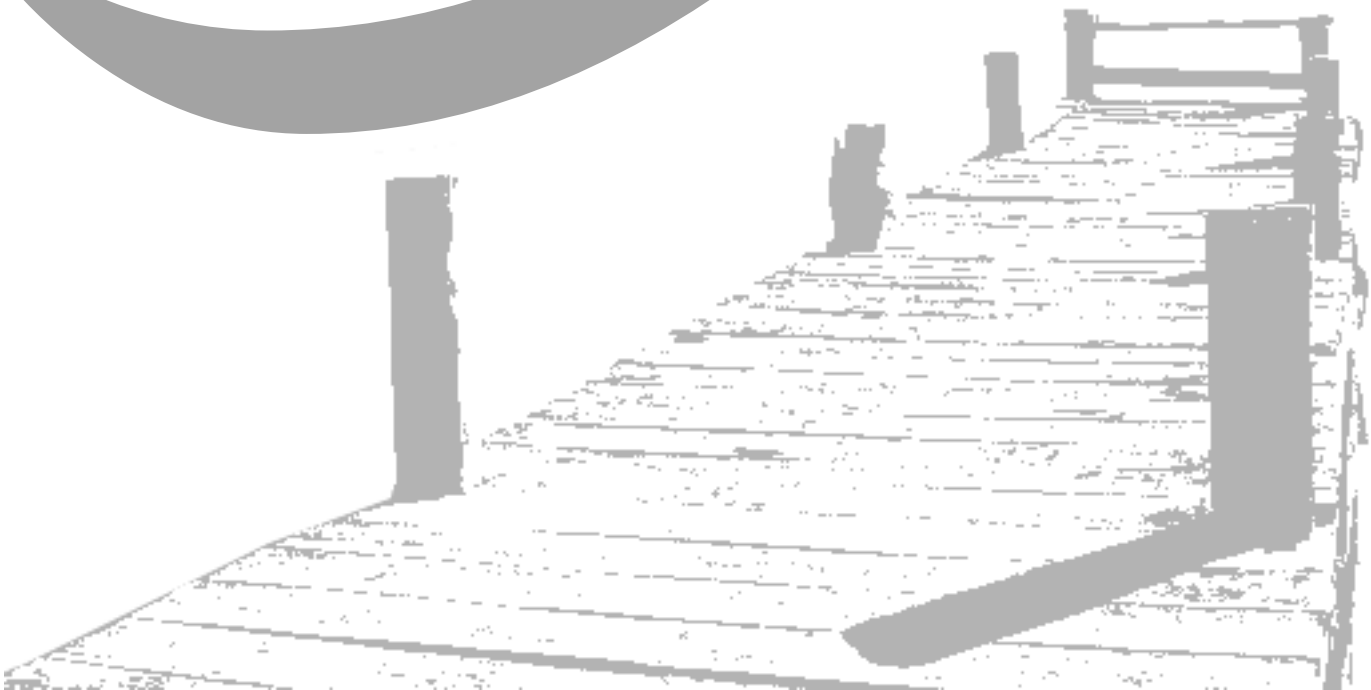
GCE
AS and A Level

# Electronics

AS exams 2009 onwards
A2 exams 2010 onwards

## Unit 4: ELEC4
## Specimen mark scheme

Version 1.1



The specimen assessment materials are provided to give centres a reasonable idea of the general shape and character of the planned question papers and mark schemes in advance of the first operational exams.

For operational papers, mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. The mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.



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## Mark Scheme

1 (a) (i) A separate program instruction bus ✓
(Harvard rather than von Neumann)

(ii) Cost effective plus reason ✓
Adaptable plus example ✓ *(3 marks)*

(b) Both need sensors for monitoring since the input conditions can vary,
(e.g. temperature of inlet water, quantity of clothes etc) ✓
Since end point is monitored, the system is closed. ✓ *(2 marks)*

(c) (i) When a portion of the output is mixed with the input ✓
to reduce the effect of the input ✓

(ii) If the speed is too low, then the output from the speed sensor is reduced so allowing the input to increase, increasing the speed of the drum and vice versa. *(3 marks)*

(d) (i) Comparator ✓

(ii) The microcontroller produces a reference voltage depending on what temperature setting has been made. ✓
The output voltage from the thermistor voltage divider is compared with this voltage and when it exceeds the reference voltage the output of the op-amp goes low indicating to the microcontroller that the temperature has been reached. ✓ *(3 marks)*

*(question total 11 marks)*

2 (a) (i) $D_7$ to top (10k) resistor, $D_0$ to the bottom resistor ✓

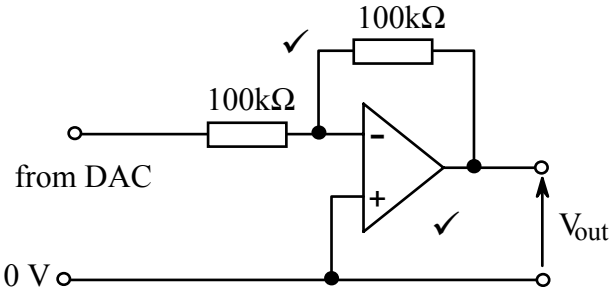
(ii) Working down, 160k, 320k, 640k and 1280k ✓ ✓ *(3 marks)*

(b) Op-amp has a very large voltage gain and so for any non-saturated output voltage the voltage on the two input terminals of the op-amp must be virtually the same ✓
Since the V+ input terminal is at 0V, then P must be virtually at 0V ✓ *(2 marks)*

(c) (i) 01010000 ✓

(ii) $V_{out} = -10\left(\frac{5}{20}+\frac{5}{80}\right) = 3.125V$ ✓ ✓ ✓ *(4 marks)*

(d) Standard inverting op-amp circuit ✓
Input and feedback resistors the same and between 1k and 1M ✓




*(2 marks)*
*(question total 11 marks)*

3 (a) Restore logic levels and make transitions between logic levels fast ✓
Remove noise ✓ *(2 marks)*

(b) (i) When the output is at 0V, the voltage divider connected to point A consists of a 47kΩ resistor at the top and two 47kΩ resistors in parallel at the bottom ✓
Combined resistance at bottom is 23.5kΩ ✓
Voltage divided into ratio of 2:1 => voltage at point A = 4V ✓

(ii) When output is 12V, there are two 47kΩ resistors at the top of the voltage divider and one 47kΩ resistor at the bottom ✓
Combined resistance at top is 23.5kΩ ✓
Voltage divided into ratio of 1:2 => voltage at point A = 8V ✓

(iii) Op-amp has a very large open loop voltage gain so acts as a comparator ✓
When the input rises above 8V, the inverting input to the op-amp is greater than the non-inverting input, so the output goes to 0V ✓
Similarly when the input voltage goes below 4V when the output is at 12V ✓ *(9 marks)*
*(question total 11 marks)*

4 (a) Advantages - e.g. larger range of characters ✓
Disadvantages - e.g. harder to drive, dimmer ✓ *(2 marks)*

(b) R2 positive with respect to C2 ✓
by the forward voltage of the LED ✓
mention of series resistor ✓ *(3 marks)*

(c) (i) Interrupt - the microcontroller continues with other tasks until the external device indicates that it needs attention. The microcontroller suspends its current operation, deals with the Interrupt request and then resumes its previous task. With polling - the microcontroller is not able to do any other tasks ✓

(ii) XXX11110, XXX11101, XXX11011, XXX10111, XXX01111 ✓ ✓ *(4 marks)*

(d) X1111100, X0001010, X0001001, X0001010, X1111100 ✓✓ *(2 marks)*

*(question total 11 marks)*

5 (a) Prevents damage to the semiconductors ✓
From the large induced voltage when a motor coil switches off ✓ *(2 marks)*

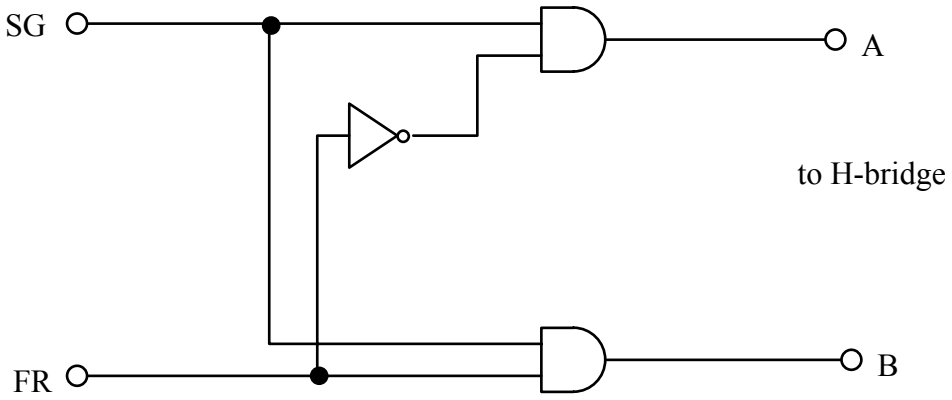
(b)

| INPUT A | INPUT B | MOTOR OPERATION |
|---|---|---|
| 0 | 0 | Off |
| 0 | 1 | Clockwise |
| 1 | 0 | Anticlockwise |
| 1 | 1 | Off |

✓ ✓ ✓ ✓ *(4 marks)*

(c) (i) $\mathbf{A = (SG) \bullet \left(\overline{FR}\right)}$ ✓
$\mathbf{B = \left(SG\right) \bullet \left(FR\right)}$ ✓

(ii)




*(5 marks)*

*(question total 11 marks)*

6 (a) (i) Inclusion of:-
Simple - Photodiode/LDR
Multiple receptor sensors e.g. CCDs
Use of IR/Visible/UV colour etc,
Ultrasound, microwaves etc
Or other relevant vision systems/techniques ✓ ✓ ✓ ✓

(ii) ANN trained with known shapes and patterns.
Then given unknown shapes/patterns to interpret.
Backwards propagation.
Or other relevant techniques ✓ ✓ ✓ ✓ *(8 marks)*

(b) Inclusion of:-
NiCd, NiMH, LiIon, Pb acid etc.
Relevant advantages and disadvantages
Or other relevant batteries ✓ ✓ ✓ *(3 marks)*
*(question total 11 marks)*

7 (a) Any relevant statements
e.g. Stepper motor – rotates through specified angle ✓
Conventional motor – rotates continuously when current applied ✓
Needs shaft encoder or encoded disk to provide control of a conventional motor ✓ *(3 marks)*

(b) Statement of recommendation ✓
Relevant justification ✓
E.g. Stepper – readily apply to situation; direct control by microcontroller; needs little additional control equipment; accurate rotation with little extra equipment
E.g. Conventional – cheaper; greater power/torque; could provide greater resolution
Or negatives ✓ ✓ *(3 marks)*

(c) For outputs a bit is 0 and for inputs a bit is 1 => byte is F0h ✓ *(1 mark)*

(d) Use prescaler to divide by 250 so load it with 250.
This gives 250µs pulses ✓ ✓
Timing register needs 200 of these pulses for 50ms so load with 200 ✓ *(3 marks)*

(e) (i) Loads the value in register 05h (PORT A) into the Working register ✓

(ii) Masks bit 5 from other possible inputs and outputs ✓

(iii) If the zero flag is set, then bit 5 is a zero ✓
test-tube A is in line with the liquid supply tube ✓ *(4 marks)*
*(question total 14 marks)*