Schmitt, stepper and optical disk revision.

1). A portable electricity generator set has to produce a 50Hz alternating supply. The speed of the diesel engine and alternator are monitored by a rotation sensor. This is achieved by having grooves cut into the edge of the engine flywheel every 10° which are detected by a reflecto-optical switch. The signals from the rotation sensor are used by a microcomputer to control the fuel supply for the diesel engine.

(a) (i) The reflecto-optical switch consists of an LED and a photodiode. Draw a diagram to show their physical arrangement.

(2)

(ii) The LED has a forward voltage of 1.9V and a maximum current of 30mA. It is operated from a 12V supply. Calculate a suitable value for the series resistor for the LED.

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(iii) What is the purpose of the series resistor?

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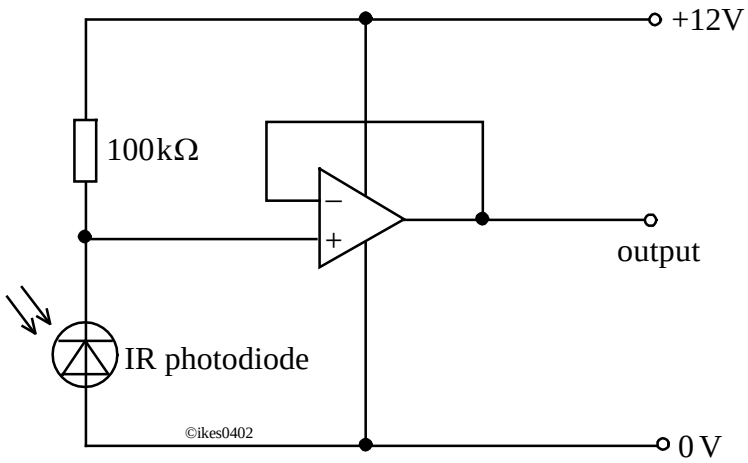
(1)

(b) The circuit diagram for the photodiode is shown below.



(i) Explain the function of the photodiode.

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(ii) Explain the function of the op-amp

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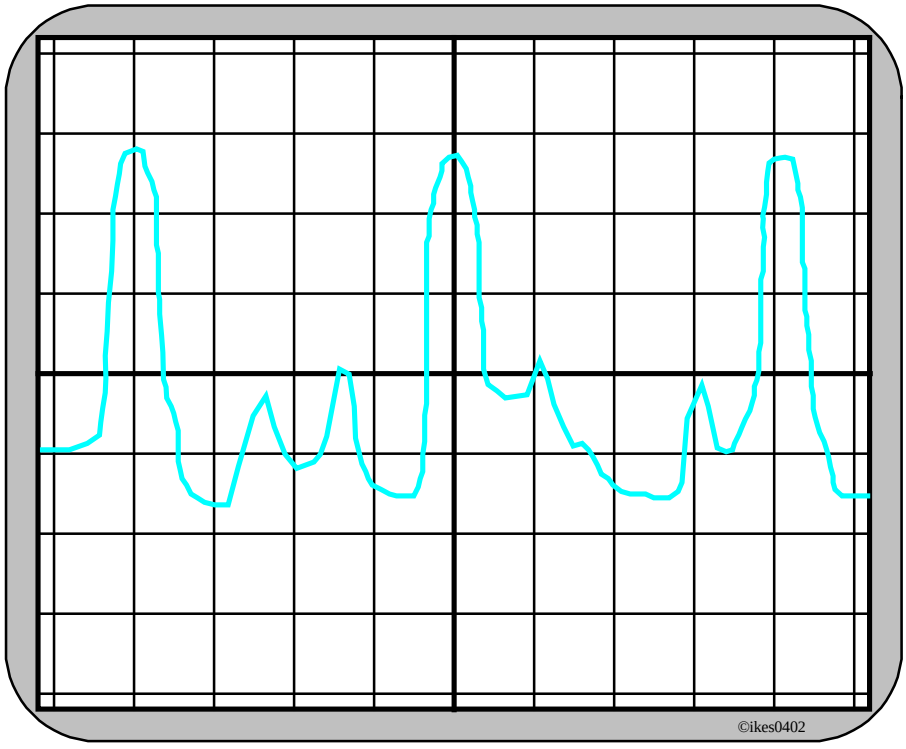
(c) The output signal from the op-amp is shown on the oscilloscope diagram below.



(i) If the y-sensitivity of the oscilloscope is 2V/div, estimate the voltage change in the output.

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(1)

(ii) What is the speed of the oscilloscope time base?

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(d) (i) Explain why this signal is unsuitable to apply to the input port of a microcomputer.

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(ii) Two suitable interfacing sub-systems between the rotation sensor and the microcomputer are the comparator and the Schmitt trigger. Describe two significant differences between these sub-systems.

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(iii) Draw the circuit diagram of a suitable comparator circuit, stating suitable component values.

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(iv) Suggest two reasons why a comparator may be unsuitable in this application.

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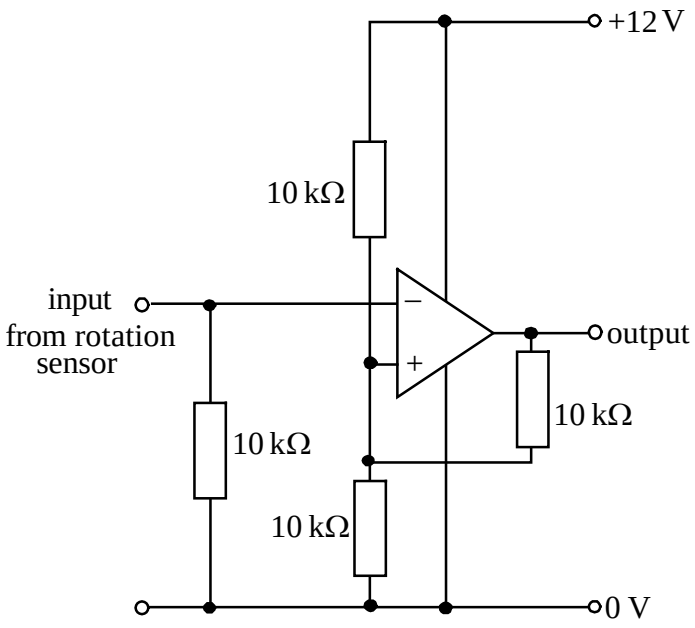
(2)

(e) The circuit below is of a Schmitt trigger that is used to interface the rotation sensor to the microcomputer. Assume that the op-amp output is either +12 V or 0 V.



(i) Suggest a reason why a Schmitt trigger is better than a comparator in this application.

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(ii) What is the voltage at the non-inverting input terminal of the op-amp when the output of the op-amp is high?

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(iii) What is the voltage at the non-inverting input terminal of the op-amp when the output of the op-amp is low?

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(iv) What are the switching voltages of the Schmitt trigger?

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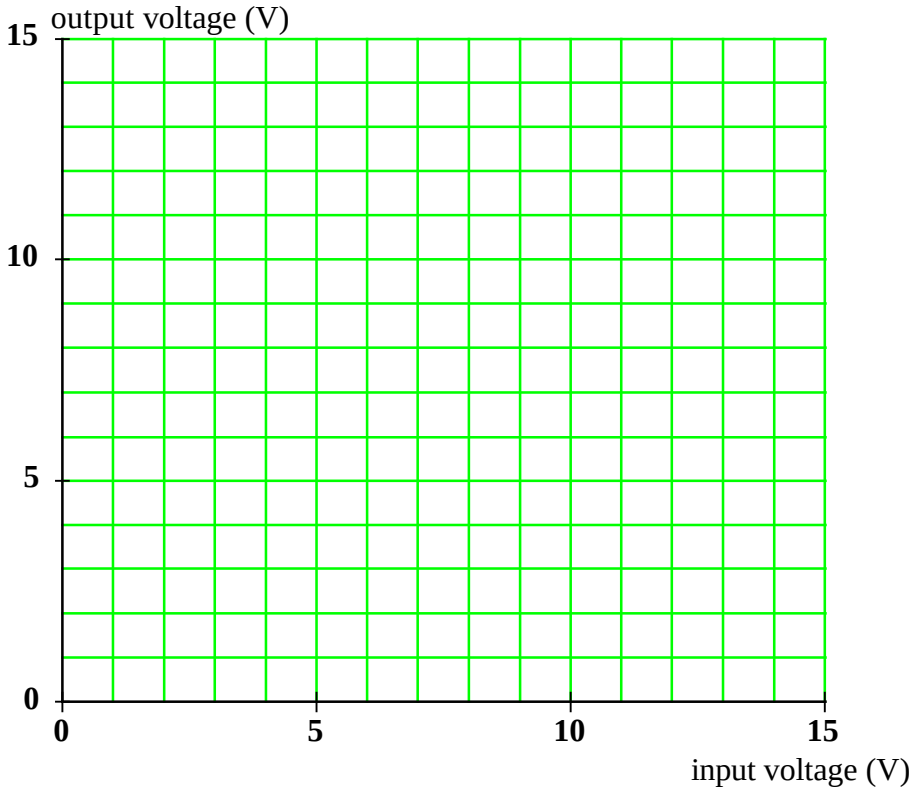
(2)

(f) (i) Draw a sketch on the axes below to show how the output voltage varies when the input voltage increases from 0 to 12V. Label the sketch *Increasing*.



(ii) Draw a sketch on the axes above to show how the output voltage varies when the input voltage decreases from 12 to 0V. Label the sketch *Decreasing*.

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(g) The output of the Schmitt trigger is applied to the BUSY input of a Centronics port (bit D_7) and the input is *Polled*.

(i) Explain what is meant by the term polled.

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(ii) Explain how this differs from an *Interrupt* method of obtaining the information from the rotation sensor.

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(h) The QBasic statement used to read the input port is:

X% = INP(&H379) AND 128

(i) Explain what this statement does.

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(2)

(ii) What two possible values can X% have?

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(i) The fuel control valve of the diesel engine is controlled by a 4 pole stepper motor.

(i) Describe two major differences between a stepper motor and a conventional motor.

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(ii) What is the smallest angle of rotation of a 4 pole stepper motor?

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(1)

(j) The stepper motor is controlled by the Centronics port of a computer. The 4 poles are to be connected via suitable driver circuits to bits D0 to D3.

(i) Draw the circuit diagram of a suitable MOSFET driver circuit for one pole of the stepper motor.

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(ii) Give **two** reasons why a MOSFET is ideally suited to this application

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(k) (i) Draw a flow diagram below to make the stepper motor rotate through an angle which is a multiple of 30°.

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(ii) Convert the flow diagram into a QBasic program.

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