

12. An industrial guillotine is fitted with two push-switches and a light-sensing circuit to sense if material is in position ready for cutting. The guillotine control circuit is shown in Figure Q12(a).

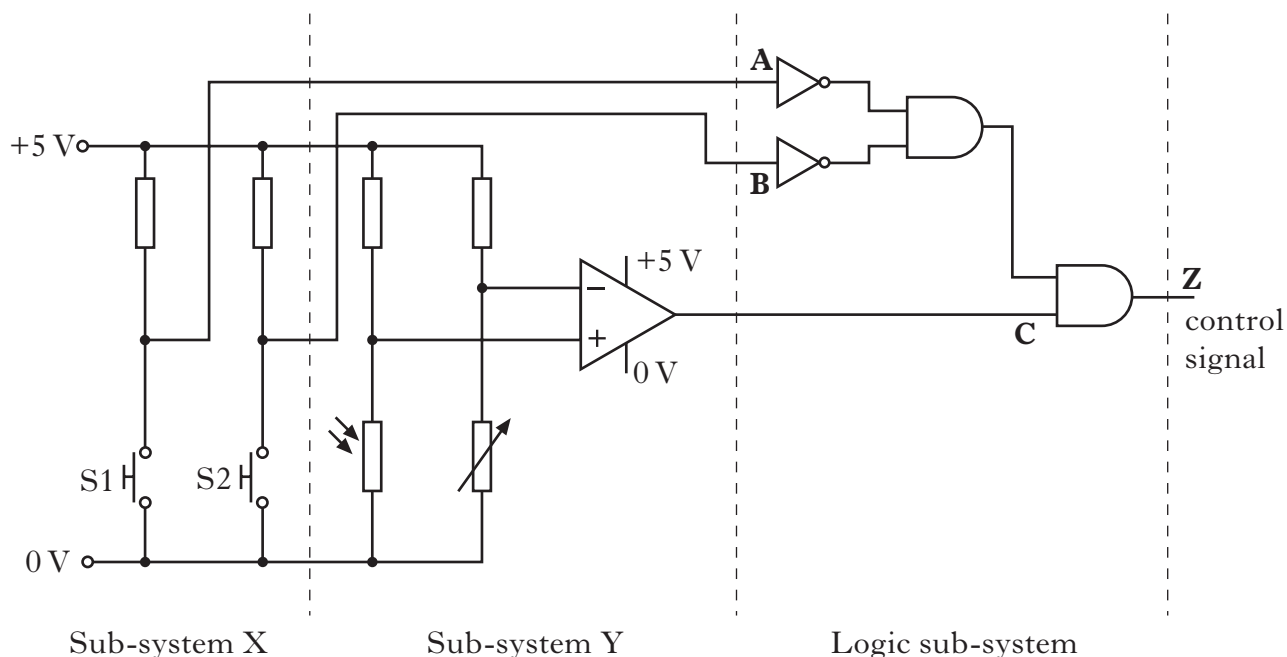


Figure Q12(a)

- (a) Describe the operation of the electronic control circuit shown in Figure Q12(a). Refer to each of the three sub-systems shown. 4
- (b) For the logic sub-system shown in Figure Q12(a), draw a truth table for the output Z in terms of the three inputs A, B and C. 1

An electronics engineer suggests that the logic sub-system shown in Figure Q12(b) would provide a simpler solution than the original sub-system.

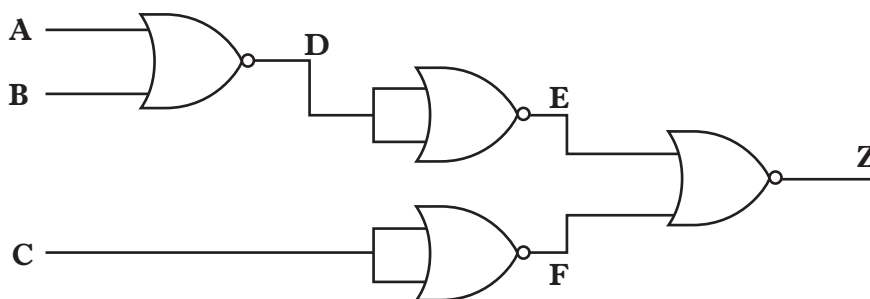


Figure Q12(b)

- (c) Demonstrate whether the logic sub-system shown in Figure Q12(b) is equivalent to the logic sub-system shown in Figure Q12(a). 3

12. (continued)

When the control signal from the logic sub-system is **high** (5 V), a driver sub-system supplies current to a solenoid valve. The driver sub-system is shown in Figure Q12(c).

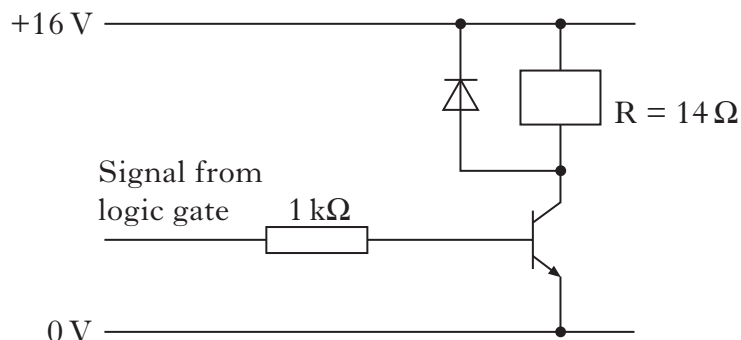


Figure Q12(c)

- (d) Calculate the current flowing into the base of the transistor when the control signal is **high**. 1

The transistor should saturate when the control signal is **high**. At saturation V_{CE} is 0.2 V.

- (e) Calculate the minimum current gain required to operate the solenoid under these conditions. 2

The circuit was modified in order to reduce the current flowing from the logic sub-system. The current gain of the driver sub-system was then 800.

Figure Q12(d) shows the operating characteristics of the available transistors.

Device	Case style	IC (max) mA	h_{FE}
BC108	T0-18	200	100
BFY51	T0-39	1000	40
TIP31A	T0-220	3000	10
BC142	T0-39	1000	20

Figure Q12(d)

- (f) Draw a modified circuit diagram for a driver sub-system with the required current gain. Use the information given in Figure Q12(d), and clearly label every device used. 2

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