# The Open University of Sri Lanka
# Faculty of Engineering Technology

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| Study Programme | : | Diploma in Technology/Bachelor of Technology (Engineering) |
| Name of the Examination | : | Final Examination |
| **Course Code and Title** | : | **MEX4242 – Automotive electronics** |
| Academic Year | : | 2013/14 |
| Date | : | 31st August 2014 |
| Time | : | 0930hr-1230hr |
| Duration | : | 3 hours |

**General instructions**

1. Read all instructions carefully before answering the questions.
2. This question paper has **six** questions.
3. Answer **Question 1 (Q1),** which is **compulsory** and **three** others.
4. Question 01 carries 40 marks where as others each 20 marks.

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Q1 (Spend approximately one hour and fifteen minutes)

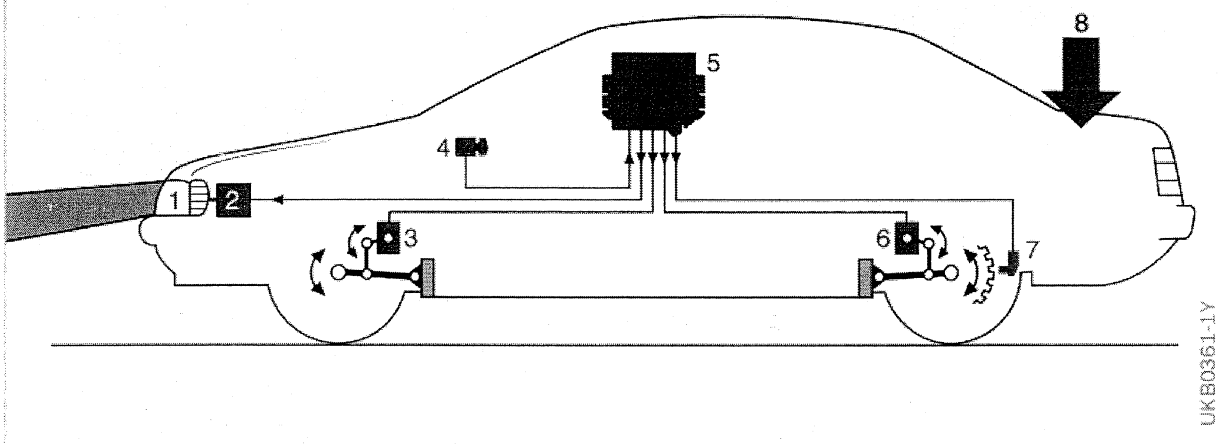
**The article on Automatic headlamp-leveling control systems, given in below, is taken from "*Bosch Automotive Electrics and Automotive Electronics book published by Robert Bosch GmbH, 2007*". Read it carefully and answer the following questions.**

***Automatic headlamp leveling control***

*Automatic headlamp-leveling control systems fall into two categories: static and dynamic. While static systems compensate for load variations in the luggage and passenger compartments, dynamic systems also correct headlamp aim during acceleration – both from standing starts and when underway and when braking.*

*The components of a typical headlamp leveling control system as shown in Figure Q1:*

- *Sensors on the vehicle axles (Items 3 and 6) to measure the body's inclination or tilt angle.*
- *An ECU (5) that uses the sensor signals as the basis for calculating the vehicle's pitch angle. The ECU compares this data with the specified values and responds to deviations by transmitting appropriate triggering signals to the headlamps' servomotors.*




*Fugue Q1:Principle of an automatic headlamp-leveling control system (dynamic system) [1: Headlamp, 2: Actuator, 3: Front suspensiontravel sensor, 4: Light switch, 5: Electronic control unit, 6: Rear suspension travel sensor, 7: speed sensor and 8: Load]*

***Static system***

*In addition to the signals from the suspension sensors, the static system's control unit also receives a speed signal from the electronic speedometer. The controller relies on this signal to decide whether the vehicle is stationary, undergoing a dynamic change in speed, or proceeding at a constant speed. Automatic systems based on the static concept always feature substantial response inertia, so the system corrects only those vehicle inclinations that are consistently registered over relatively long periods.*

*Each time the vehicle has pulled away, it corrects the headlamp adjustment as a function of the vehicle's load. This adjustment is checked again when the vehicle steadies into constant-speed travel and is then corrected if necessary. Deviations between the target and actual position are evened out by the system.*

*The static system only generally requires a sensor on the rear axle of the vehicle. A DC motor is used as each headlamp's actuator.*

***Dynamic system***

*The dynamic automatic system relies on two distinct operating modes to ensure optimal headlamp orientation under all driving conditions. Supplementary capabilities in speed-signal analysis over the static headlamp leveling control endow the system with the ability to differentiate between acceleration and braking.*

*With the vehicle driving at constant speed, the dynamic system, like the static system, remains in the range that features a high level of damping but as soon as the controller registers acceleration or braking, the system immediately switches to its dynamic mode. Faster signal processing and the higher servomotor adjustment speed allow the headlamp range to be readjusted within fractions of a second. Following acceleration or braking, the system automatically reverts to operation in its delayed-response mode.*

*Due to the greater dynamics requirements, the dynamic system needs one sensor per vehicle axle and rapid stepping motors to adjust the headlamps.*

(a) Identify the sensors and actuators considered in the automatic headlamp-leveling control systems shown in Figure Q1. Explain the operation of each sensor and actuator.

[10 Marks]

(b) Draw the block diagrams of the staticheadlamp-leveling control system and dynamic headlamp-leveling control systemseparately and briefly explain the operation of both systems.

[10 Marks]

(c) Design a dynamic headlamp-leveling control system using a microcontroller. Clearly show input/output interface circuit with sensors and actuators.

[10 Marks]

(d) Represent algorithm using a flowchart or pseudo-code to fulfill the function of dynamic headlamp-leveling control system.

[10 Marks]

Q2

(a) List different types of mass air flow sensors.

[3 Marks]

(b)

i Explain the operation of mass air flow sensor shown in Figure Q2.

[6 Marks]

ii What are the advantages of using Wheatstone bridge configuration in this sensor?

[3 Marks]

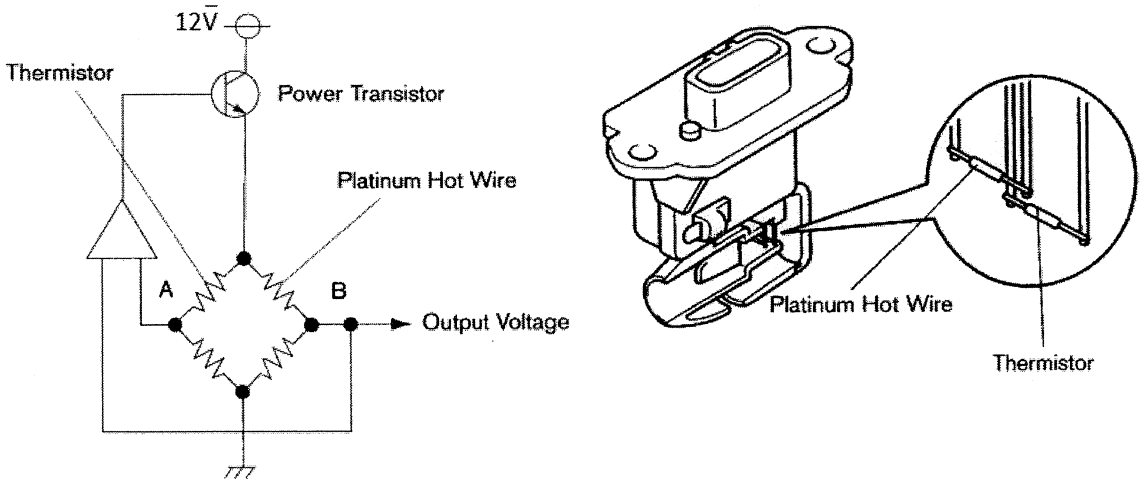



Figure Q2

(c) What is the type of output signal generated by the mass air flow sensor? What would be the expected output when vehicle speed is increased?

[4 Marks]

(d) Explain the necessary steps you have to take when an air mass flow sensor is connected to a microcontroller.

[4Marks]

Q3

A car is fitted with an alarm which sounds a buzzer when the outside temperature falls below 3 $^{0}C$.

The sensor is a thermistor located under the mirror on the side of the car as shown in Figure Q3 (a).

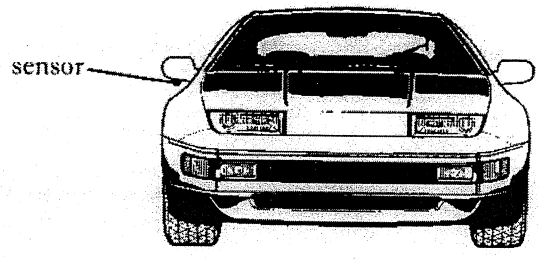



Figure Q3(a)

The thermistor forms part of the circuit shown in Figure Q3 (b).

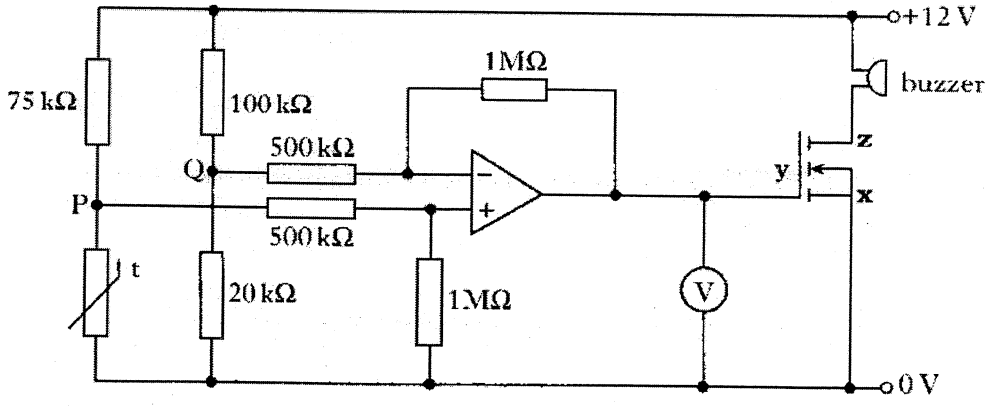



Figure Q3 (b)

(a) What names are given to the terminals labelled **x**, **y** and **z** on the symbol for the MOSFET? Clearly indicate which name goes with which letter.

[3 Marks]

(b) The buzzer sounds when the reading on the voltmeter is greater than or equal to +2.0V.

i Calculate the minimum potential difference required between points P and Q to sound the buzzer.

[12 Marks]

ii Calculate the resistance of the thermistor when the buzzer sound.

[5 Marks]

Q4

(a) Draw the circuit symbol, and V vs I characteristics of a typical zener diode.[ 4 Marks]

(b) The voltage regulator circuit shown in Figure Q4 uses 7V zener diode. The load current is varying from 12 mA to 100 mA. The input supply voltage remains constant at 12V.

i. Determine a suitable value for the series resistance $R_S$ so as to ensure a minimum current of 10 mA through the zener diode. [12 Marks]

ii. Determine the maximum power rating of the zener diode. [4 Marks]

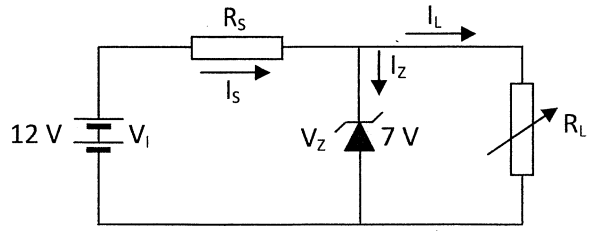



Figure Q4

Q5

(a) Explain the function of the cruise control system.

[5 Marks]

(b) Explain what factors should be considered in designing a vehicle cruise control system.

[5 Marks]

(c) What are the main components of the antilock braking system? Explain the functional components.

[5 Marks]

(d) Briefly explain the overall function of the system using a diagram

[5 Marks]

Q6

(a) Find the minimum sum of products and product of sums form of the following function using the Karnaugh map.

$$F(A,B,C,D) = \sum(5,7,8,9,10) + dc_terms(0,1,13,15)$$

[8 Marks]

(b) The stair case lights of a building having four floors, can be switched on or off at any floor when the switch on that floor is operated. Design a logic circuit for this case using a minimum number of gates. Show the design steps clearly. If the lights are controlled through a relay show a suitable circuit capable of doing this.

[12 Marks]

**End**