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

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| Study Programme | : | Bachelor of Technology Honours in Engineering |
| Name of the Examination | : | Final Examination |
| **Course Code and Title** | : | **MEX4142 – Applied automotive electronics**<br>**MEX4242 – Automotive electronics** |
| Academic Year | : | 2014/15 |
| Date | : | 14th September 2015 |
| 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** other.
4. Question 01 carries 40 marks where as others each 20 marks.

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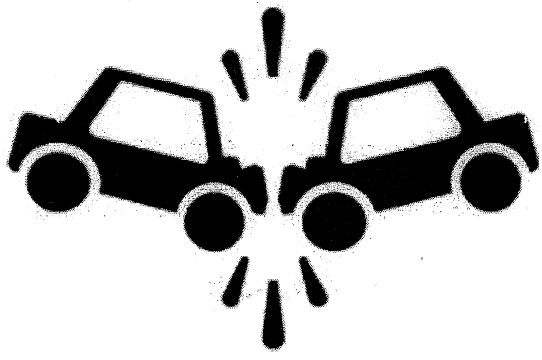
Q1 (spend approximately one hour and fifteen minutes)

**The article of "Event Data Recorders and Accident Recorder" given in below taking from "*http://www.cvel.clemson.edu/auto/systems/auto-systems.html*". Read it carefully and answer the following questions.**

## Event Data Recorders and Accident Recorders

### Event Data Recorders

#### Basic Description



Event data recorders (EDRs), sometimes referred to as automotive "black boxes", are systems that constantly record information related to the vehicle operation. In the event of

an accident, the recorder saves the information that was recorded several seconds just before and/or just after the collision. EDRs may be independent electronic control units or they may reside within other control modules such as the engine control (ECM) or airbag control module.

Unlike Accident Recorders, which are after-market systems that usually record video and GPS location data, EDRs are installed by the vehicle manufacturer and integrated with existing systems and sensors. In the U.S., most passenger cars, multipurpose passenger vehicles, trucks, and buses manufactured after September 1, 2014 are required to have an EDR installed. Modern EDRs record various operational parameters such as vehicle speed, pedal positions, steering wheel position and other information that may be relevant to a crash investigation. In the event of a crash, about 5 seconds of this data is stored in non-volatile memory.

Requirements for the type of data that must be recorded by EDRs in the U.S. are spelled out in the Code of Federal Regulation, 49 CFR Part 563. This regulation requires that EDRs record the following data:

- Change in forward crash speed
- Maximum change in forward crash speed
- Time from beginning of crash at which the maximum change in forward crash speed occurs
- Speed vehicle was traveling
- Percentage of engine throttle, percentage full (how far the accelerator pedal was pressed)
- Whether or not brake was applied and the antilock brakes were activated
- Ignition cycle (number of power cycles applied to the EDR) at the time of the crash
- Ignition cycle (number of power cycles applied to the EDR) when the EDR data is downloaded
- Whether or not driver was using a safety belt
- Whether or not frontal airbag warning lamp was on
- Driver frontal airbag deployment: time to deploy for a single stage airbag, or time to first stage deployment for a multistage airbag
- Right front passenger frontal airbag deployment: time to deploy for a single stage airbag, or time to first stage deployment for a multistage airbag
- Number of crash events
- Time between multiple crash events
- Whether or not EDR completed recording

The regulation also specifies additional parameters that must be recorded under certain minimal conditions, including:

- Change in lateral vehicle speed
- Maximum change in lateral speed
- Time from beginning of crash at which the maximum change in lateral crash speed occurs

- Engine RPM
- Steering wheel angle
- Vehicle roll angle, in case of a rollover
- Antilock braking system status
- Electronic stability control status
- Safety belt status
- Front air bag suppression switch status
- Front air bag deployment status
- Side air bag deployment status
- Front seat positions
- Front passenger occupant size
- Front passenger occupant position

The regulation also requires that automakers ensure that there is a commercially available tool for downloading the EDR data.

EDRs are not required in Europe, but a recent study concluded that "all (or almost all)" new passenger cars sold in Europe have EDRs that record information comparable to the U.S. requirement.

**Accident Recorders**

**Basic Description**

Accident recorders are systems that constantly record information related to the vehicle operation.

In the event of an accident, the recorder saves the information that was recorded several seconds just before and/or just after the collision.

Unlike Event Data Recorders, which are installed by the automotive manufacturer and are required on new cars sold in the U.S., accident recorders are after-market systems usually mounted just behind the windshield or on the rear-view mirror. Event data recorders store several seconds of vehicle information which is constantly being overwritten until there is an airbag deployment. Accident recorders may record minutes or even hours of data. Event data recorders do not record video, date and time, or GPS information; while accident recorders often record video inside and/or outside the vehicle while tracking the time and location of the vehicle. Accident recorders may also monitor other parameters such as vehicle speed and vehicle acceleration using their own internal sensors, or by tapping in to the vehicle's on-board diagnostic system.

Accident recorders are often installed in fleet vehicles. They can help protect a company in the event the company is sued following an accident involving one of their drivers. There is also a growing number of drivers that elect to install accident recorders (sometimes referred to as *dash cams*) in their personal vehicles in order to protect themselves from false liability claims in the event of an accident.

(a) Identify the sensors and actuators used in the event data recorder (EDR) and accident recorder. Explain the operation of each sensors and actuators.

[Marks10]

(b) Draw block diagrams of the event data recorder and accident recorder separately and briefly explain the operation of both systems.

[Marks10]

(c) Design an event data recorder and accident recorder with using a microcontroller. Clearly show input/output interface circuit with sensors and actuators.

[Marks10]

(d) Present an algorithm using a flow chart or pseudo-code to fulfill the function of event data recorder and accident recorder.

[Marks10]

Q2

(a) Find the minimum sum of products following function using K – map and implement the minimized function using **NAND** gates.

$$f(A,B,C) = \sum 0,1,2,3,4,5,6$$ [Marks 8]

(b) Design a 3-bit synchronous counter using JK Flip-Flop and logic gates. You have to show the state diagram, state table, K-map, logic expressions and the circuit implementation very clearly.

[Marks 12]

Q3

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

[Marks 3]

(b)

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

[Marks 5]

ii What is the reason to connect Zener diode across transistor output?

[Marks 2]

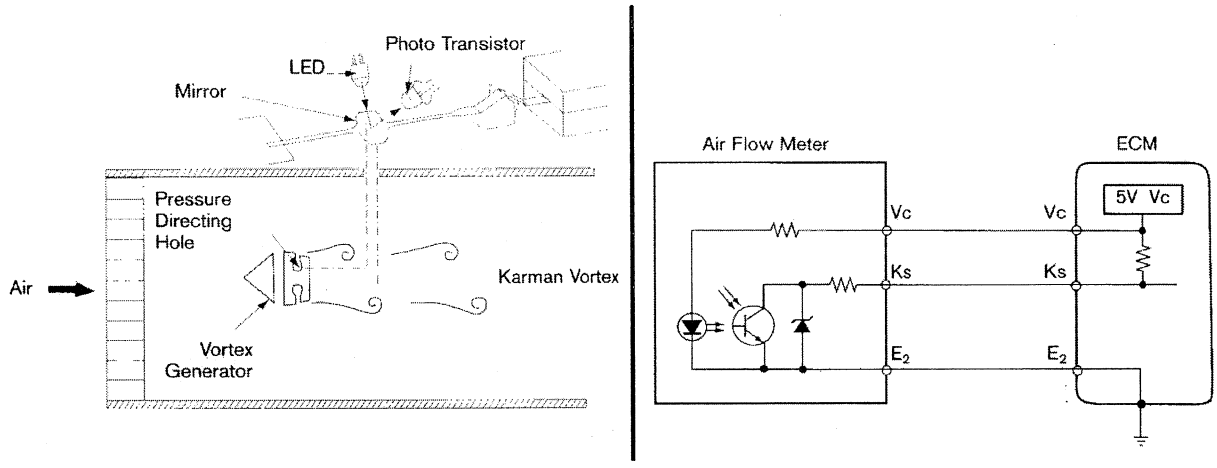



Figure Q2

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

[Marks 5]

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

[Marks 5]

Q4

(a) Briefly explain the active suspension control system in a vehicle using block diagram.

[Marks 10]

(b) List sensors and actuators used in active suspension control system.

[Marks 5]

(c) Write an algorithm or a flowchart for the operation of the active suspension control system.

[Marks 5]

Q5

(a) Vehicle speed sensors can be divided in to two categories, what these categories. And help of diagram briefly explain their operations.

[Marks 10]

(b) Draw the output wave form patents of each speed sensor. ? What would be the expected output when vehicle speed increased?

[Marks 10]

Q6

The figure Q6 illustrates *Tire Slip Detector and Fuel Flow Interruptor* circuit. This circuit can detects wheel slip by detecting an unusually high rate of change of wheel speed. and also can control fuel supply to the engine.

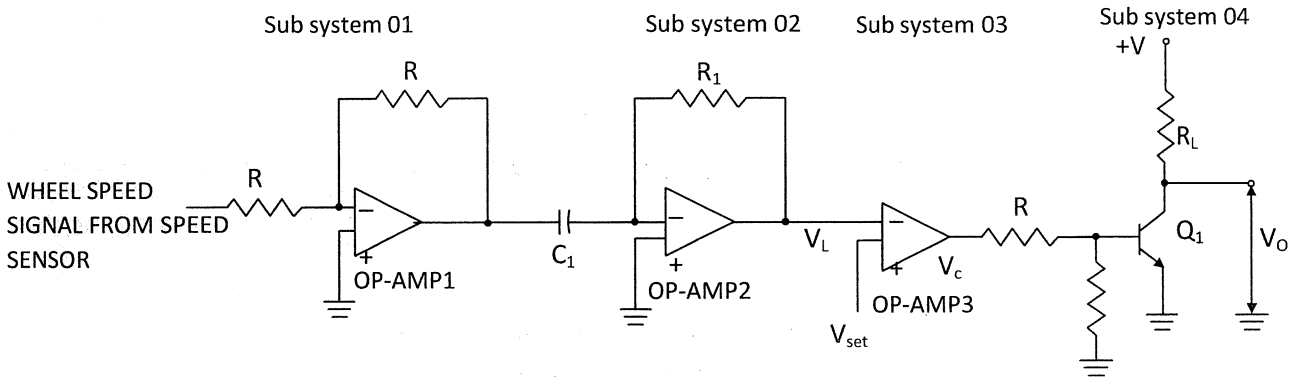



Figure Q6

(a) Explain the function of each sub system of *Tire Slip Detector and Fuel Flow Interruptor* control circuit. [Marks 06]

(b) If wheel speed signal from speed sensor is $V_{in}$ find the output voltage signal of Lead Amplifier ($V_L$). [Marks 04]

(c) If $V_L \leq V_{set}$ and $V_L \geq V_{set}$ draw output wave form ($V_C$) of comparator. [Marks 05]

(d) Explain what is the purpose of the $Q_1$ transistor. And draw output wave form of $Q_1$ transistor according to output of comparator. [Marks 05]

**End**