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The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Mechanical Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**:DMX4342/MEX4142 - Automotive electronics**
Academic Year	: 2017/18
Date	:14th February 2019
Time	: 0930-1230hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Six (06)** questions in **five (05)** pages.
3. Answer **Question 1 (Q1),** which is **compulsory** and **three other**
4. Question 01 carries 40 marks where as others each 20 marks.
5. Answer for each question should commence from a new page.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Q1 (spend approximately one hour and fifteen minutes)

The article of "Idle Stop-Start Systems" given in below taking from "*http://www.cvel.clemson.edu/auto/systems/auto-systems.html*". Read it carefully and answer the following questions.

Idle Stop-Start Systems

Basic Description

The Idle Stop-Start System is a low cost method for increasing fuel economy and decreasing emissions. The system turns off the internal combustion engine when the vehicle stops at a stop light or during stop and go traffic where the vehicle would normally idle for a minimum of three to five seconds. The engine is then automatically restarted when the driver is ready to proceed. An electronic control unit determines an appropriate time to turn off the engine based on data from various sensors. An auto start/stop system can reduce greenhouse-gas emissions by 5% to 7%. The system is currently available on most hybrid vehicles and on several non-hybrids such as BMW's *EfficientDynamics* vehicles and Mazda vehicles with i-Stop.

The Figure Q1 illustrate how the system works on a full hybrid 2007 Toyota Prius. When the vehicle comes to a complete stop, the engine is turned off. Notice how the energy monitoring computer shows no flow of energy. When the brake pedal is released, the electric power from the battery is used to start the engine and assist in the initial acceleration. The arrows show the flow of energy from the battery to the electric motor that provides torque to the wheels. When engine power is required, the engine is quickly started and assists the electric motor in powering the vehicle.

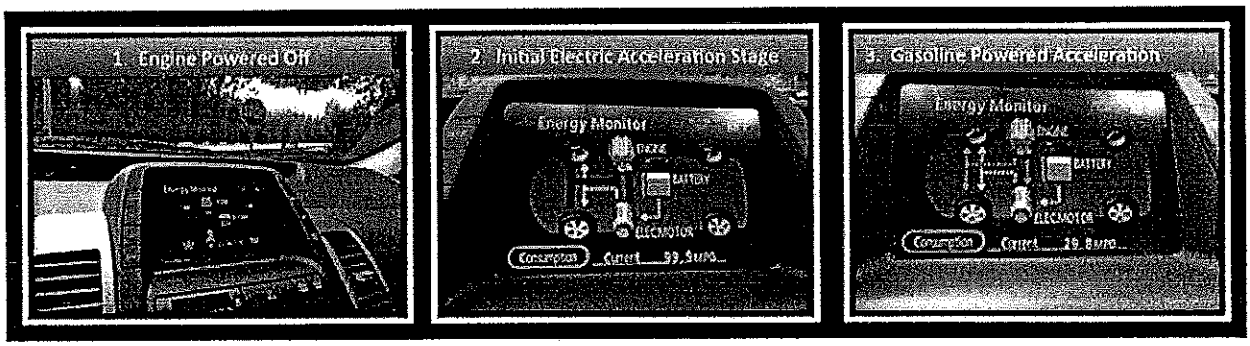

figure Q1

The concept is simple; however numerous parameters must be monitored and controlled in order to deliver a seamless user experience when using the idle stop-start system. The system must monitor the state of charge (SOC) of the battery to ensure that the engine can be started again. In addition, the engine temperature is monitored to avoid cold starts. This ensures complete combustion and optimal operation of the catalytic converter, thus reducing emissions.

Model of Electronic Control System for Idle Start/Stop System

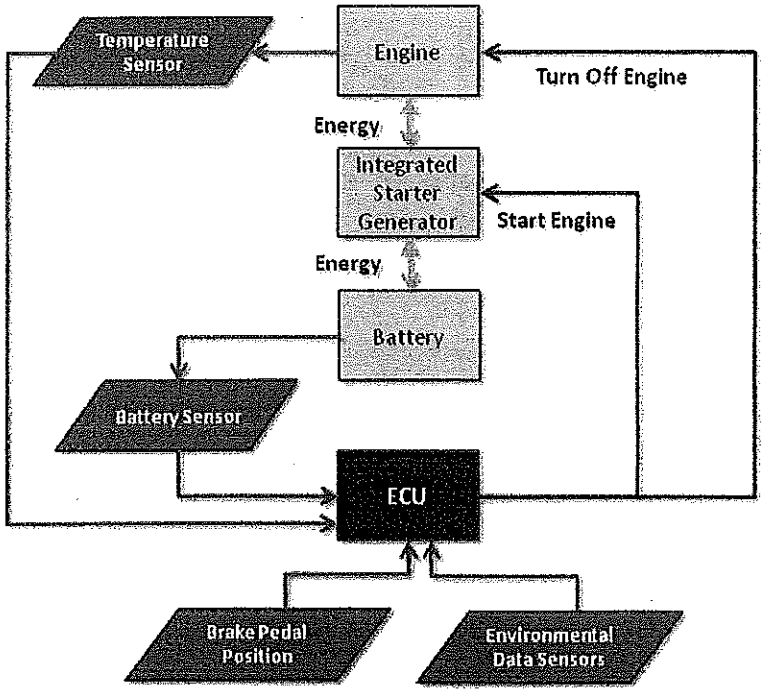

figure Q1b

Various manufactures employ different methods to quickly restart the engine. Many manufactures, such as General Motors, choose to use an *integrated starter generator*, which essentially combines a heavier-duty starter and alternator into one unit. The unit is able to quickly and smoothly restart the engine and then begin recharging the battery. The unit can be used for regenerative braking as well to recharge the battery. Mazda's unique i-Stop system restarts the engine using combustion rather than a starter motor alone. The system precisely controls the engine shutdown procedure so that the pistons of the engine are in optimal positions. The system then selects the cylinder with optimal location in the combustion cycle to restart the engine. Fuel is injected into the cylinder and ignited to restart the engine with the assistance of a traditional starter motor. Mazda claims this system is able to restart the engine in just 0.35 seconds, twice as fast as starter motor only methods.

Start-stop systems have been popular in Europe since the 1980s, but have only recently been introduced to the U.S. market. Audi, BMW, Chrysler, Daimler, Fiat, Ford, General Motors, Honda, Hyundai/Kia, Jaguar, Land Rover, Mazda, Nissan, PSA Peugeot, Citroën, Renault, Toyota, Volkswagen, and Volvo now offer models with start/stop systems in the U.S. The popularity of these systems will likely continue to increase due to pressure to comply with corporate average fuel economy (CAFE) standards that currently target an average of 54.5 mpg by 2025.

(a) Identify sensors and actuators used in the Idle Stop-Start Systems. Explain the operation of sensor and actuator. [Marks10]

(b) Draw block diagrams of Idle Stop-Start Systems and briefly explain the operation of the system. [Marks10]

(c) Design an Idle Stop-Start Systems 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 Idle Stop-Start Systems. [Marks10]

Q2

Consider the transistor switch circuit shown in the Figure Q2. The transistor has following characteristics: $h_{FE} = 100$, $I_{CO} = 50\mu A$, $V_{CE(sat)} = 0.2$ V.

a) Determine I_B, I_C, V_C, and power dissipation in the transistor when the switch S is open state and closed state separately. [Marks 6]

b) What is the used of 10 kΩ resistor and the capacitor C? [Marks 4]

c) Calculate the maximum theoretical value possible for R. [Marks 5]

d) If the light bulb in the circuit is replaced by a relay switch having same specifications. State the additional precautions that must be taken for safe operation of the circuit. [Marks 5]

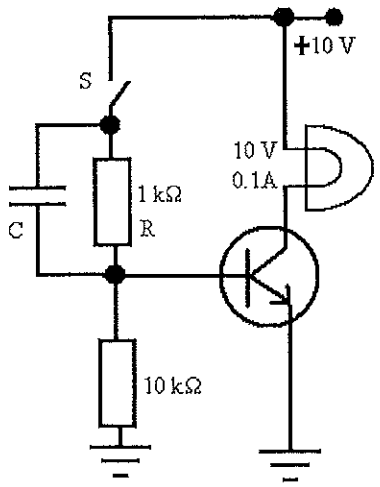

Figure Q2

Q3

(a) Briefly explain what is an ambient light sensor? [Marks 03]

(b) State applications of ambient sensor in automobile industry. [Marks 04]

(c) Briefly explain operation of following ambient sensors

i. Photoresistors or Photocells
ii. Photodiodes

[Marks 08]

Q4

In automobiles knock sensors are used to detect engine knock and it's sent a voltage signal to the ECM (Electronic Control Module)

(a) Explain the operation of knock sensor? [Marks 05]
(b) Name three possible locations to detect the engine knock. [Marks 05]
(c) How do you analyze the output of a knock sensor? [Marks 04]
(d) Plot the typical output voltage pattern with respect to the frequency, when knock occurs. [Marks 06]

Q5

(a) Draw circuit symbol and V vs I characteristics of a typical zener diode. [Marks 05]

(b) The voltage regulator circuit shown in Figure Q5 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 suitable value for the series resistance R_S so as to ensure a minimum current of 10 mA through the zener diode. [Marks 11]
ii. Determine the maximum power rating of the zener diode. [Marks 04]

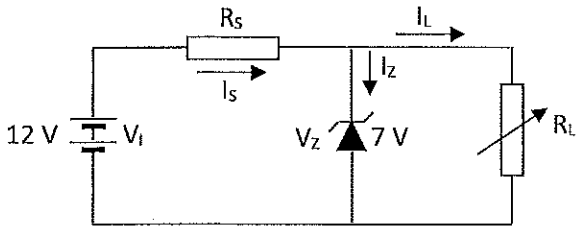

Figure Q5

Q6

(a) Give four characteristics of an ideal operational amplifier (Op-Amp) and compare the ideal values with its typical values. [Marks 05]
(b) Explain following terms of an operational amplifier

i. Input off set current
ii. Output offset voltage
iii. Common Mode Rejection Ratio (**CMRR**) [Marks 06]

(c) Design a circuit that gives ±9V using following component and device.
Two Op-Amps, +12V voltage source, one 3 kΩ, one 9 kΩ and two 10 kΩ resistors. [Marks 09]

End