



UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 5 Examination in Engineering: March 2022

Module Number: ME 5210

**Module Name: Electric and Hybrid Vehicle
Engineering (C-18)**

[Three Hours]

[Answer all questions. Question Q1 carries 20 marks. Question Q2, Q3, and Q4 carries 10 marks each]

All assumptions must be stated clearly. Sketches and diagrams are to be provided where required. Symbols stated herein denote standard parameters.

- Q1 1 A fuel cell produces electricity from _____ and _____.
- Gasoline/oxygen
 - Nitrogen/hydrogen
 - Hydrogen/oxygen
 - Water/oxygen
- 2 What are the by-products (emissions) from a fuel cell?
- Water
 - CO₂
 - CO
 - Nonmethane hydrocarbon
- 3 Which type of fuel cell is the most likely to be used to power vehicles?
- PAFC
 - PEM
 - MCFC
 - SOFC
- 4 Which liquid fuel could be used to directly power a fuel cell?
- Methanol
 - Ethanol
 - Biodiesel
 - Unleaded gasoline
- 5 Hydrogen is commonly stored at what pressure?
- 100,000 PSI
 - 50,000 PSI
 - 5,000 PSI
 - 1,000 PSI

- 6 A plug-in hybrid is different from a conventional hybrid electric vehicle because it has _____.
- A built-in battery charger
 - Li Ox batteries
 - More batteries
 - Bigger motor/generator
- 7 Which energy source(s) is (are) currently being used to help reduce the use of fossil fuels?
- Hydrogen
 - Wind power
 - Hydroelectric power
 - Both b and c
- 8 Which of the following is NOT the type of Hybrid Vehicle?
- Plug-in Hybrid
 - Parallel Hybrid
 - Natural Gas for Vehicles
 - Series Hybrid
- 9 The Hybrid Electric Vehicle consists of:
- Internal Combustion Engine + Electric Motor
 - Motor Electric 1 + Motor electric 2
 - NGV engine + Gasoline engine
- 10 "In this system, the engine is used to supply electrical power to the motor, which then turns the wheels". Select the type of Hybrid System according to the above description.
- Series Hybrid
 - Parallel Hybrid
 - Plug-in Hybrid
 - Series-parallel Hybrid
- 11 "The wheels are driven by both the engine and the motor". Select the type of Hybrid System according to the above description.
- Series Hybrid
 - Parallel Hybrid
 - Plug-in Hybrid
 - Series-parallel Hybrid
- 12 Select the features of Hybrid Electric Vehicles
- Idle Stop
 - EV Drive
 - Motor Assist
 - Regenerative Braking
 - All of above

- 13 The electric motor in a hybrid car can also act as:
- cooling fan
 - fuel pump
 - generator
- 14 Regenerative braking involves:
- nanofibers that repair the surface of brake pads
 - reducing the amount of friction necessary to slow a car
 - reclaiming heat from the brakes and using it for power
- 15 The benefits of a hybrid car include (select many answers):
- reducing emissions
 - improving gas mileage
 - high fuel consumption
 - high-speed driving
- 16 A _____ is a vehicle that can run on just the engine, just the batteries, or a combination of the two.
- Mild Hybrid
 - Full Hybrid
 - Fuel Cell
 - Assist Hybrid
- 17 A Toyota Prius C Hybrid has ____ engine.
- 1
 - 2
 - half
 - no
- 18 Select the cycle use in a Hybrid Engine.
- Otto
 - Diesel
 - Atkinson
 - Isentropic
- 19 Select the WRONG statement.
- Toyota produced the Insight Hybrid
 - Hybrid systems rely on very high voltages.
 - All of the high-voltage cables are covered in orange sleeves for easy identification.
 - To test high-voltage systems you need a Category 3 (CAT III) digital volt ohmmeter
- 20 Select the CORRECT statement about Integrated Motor Assist (IMA) hybrid system
- Produced by Honda
 - This system is the basis for many series-parallel hybrid vehicles.
 - This system is capable of instantaneously switching from one power source to another or combining the two.

[20 Marks]

- Q2 a) What is Regenerative Braking Systems? Discuss with the suitable details. [2.0 Marks]
- b) Explain the basic techniques to improve vehicle fuel economy. [2.0 Marks]
- c) Discuss the methods of energy conversion and storage and discuss the limitations when implementing/ designing a regenerative braking systems in EVs and HEVs. [6.0 Marks]

- Q3 a) Discuss economic and environmental problems associated with the current transportation scenario in the world and the hybrid electric vehicles (HEVs) would be possible solution for that. [6.0 Marks]
- b) Why electric vehicles (EV) are not the solution for above problems discussed in Q4 (a) in Sri Lanka? [4.0 Marks]

Q4 "Fuel cells are considered to be one of the advanced power sources for applications in transportation. Compared with the internal combustion engines (ICE), fuel cells have the advantages of high energy efficiency and much lower emissions. However, vehicles powered solely by fuel cells have some disadvantages, such as a heavy and bulky power unit caused by the low power density of the fuel cell system, long start-up time, and slow power response. **Hybridization** of the fuel cell system with a peaking power source is an effective technology to overcome the disadvantages of the fuel cell-alone-powered vehicles".

- a) Draw the configuration of a fuel cell-powered hybrid drive trains system, name the important parts and briefly explain the working of the system. [5.0 Marks]
- b) Describe the control strategies used for following operating modes of the drive train and corresponding power control strategy.
- (i) Standstill Mode
 - (ii) Braking Mode
 - (iii) Traction Mode
- [5.0 Marks]