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	:	**MEX6231/ DMX6531 Automotive Engineering**
Academic Year	:	2019/20
Date	:	11th October 2020
Time	:	0930 hours - 1230 hours
Duration	:	**3 hours**

General instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **seven (07) questions and five (05) pages**.
3. **Answer any 05 questions only**. All questions carry equal marks.
4. Answer for each question should commence from a new page
5. Relevant charts/ equations are provided and do not use Red colour pen.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear handwriting.

Question 01 – (*20 marks*)

Following observations were made while testing a four stroke automobile gasoline engine using an electric swinging field dynamometer

No of cylinders	4
Bore diameter	140mm
Stroke length	142mm
Voltage reading of alternator	140V
Amperage reading	160A
Alternator efficiency at given speed	56%
Speed of engine	4000 rev/min
Fuel consumption	0.21 kg/min
Calorific value of fuel	44000 KJ/kg
Quantity of air supply	2.6kg/min
Gas constant for air	0.287KJ/kg K
Air aspirated at pressure	860000 N/m^2
Air aspirated temperature	28^0C

Determine the following parameters.

i) Air fuel ratio
ii) Brake power
iii) Brake Mean Effective Pressure
iv) Specific Fuel Consumption
v) Brake Thermal Efficiency
vi) Volumetric efficiency

Question 02 – (*20 marks*)

(a) Starting from first principles, show that the air standard efficiency of an engine, working on the Otto cycle is given by;

$$\eta = 1 - \frac{1}{r^{\gamma-1}}$$

(b) Using a neat graph, show the variation of HC, CO and NO_x emission concentrations with air/fuel ratio for a non emission controlled automobile gasoline engine.

(c) On the same graph show the following

i) Region for maximum fuel economy
ii) Region for lowest harmful emission concentrations
iii) How this behavior would change by fixing a three way catalytic converter to the exhaust system of the engine.

Question 03 – (*20 marks*)

(a) By means of block diagrams, briefly explain the main difference between point to point wiring system and CAN system.

(b) Explain what Message Arbitration is with respect to CAN protocol.

(c) List four alternative fuels for automobiles and describe their;
i) physical and chemical characteristics
ii) production process and
iii) exhaust emissions

(d) List five basic measurements and the corresponding sensors that are being used to determine the correct amount of fuel to be injected when ME Motronic engine management system is used.

Question 04 – (*20 marks*)

(a) Briefly explain how accidentally reverse selection during forward drive is prevented in modern automatic gear systems.

(b) Modern transmission systems are designed to adapt automatically to driving styles and environmental conditions (adaptive controlling). Briefly explain how the systems adapt to following conditions.
i) Stop and Go Driving
ii) Curve Recognition
iii) Winter Drive Program
iv) Cruise Control Program
v) Hill Recognition Program

(c) Figure Q04 shows five time multi point injection pattern for a typical common rail diesel engine. Briefly explain the significance of each point.

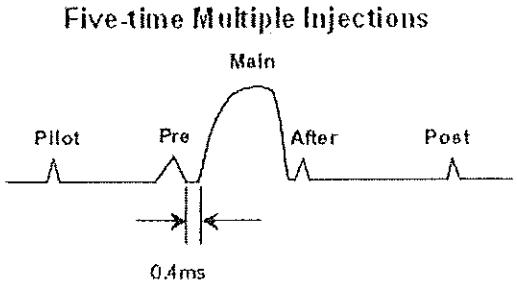

Figure Q04

(d) Briefly explain how the basic injection quantity is calculated in a common rail diesel fuel injection system

Question 05 – (*20 marks*)

(a) Main components of an ABS system are shown in Figure Q05(a). Explain the operation of all major sensors and the ABS modulator.

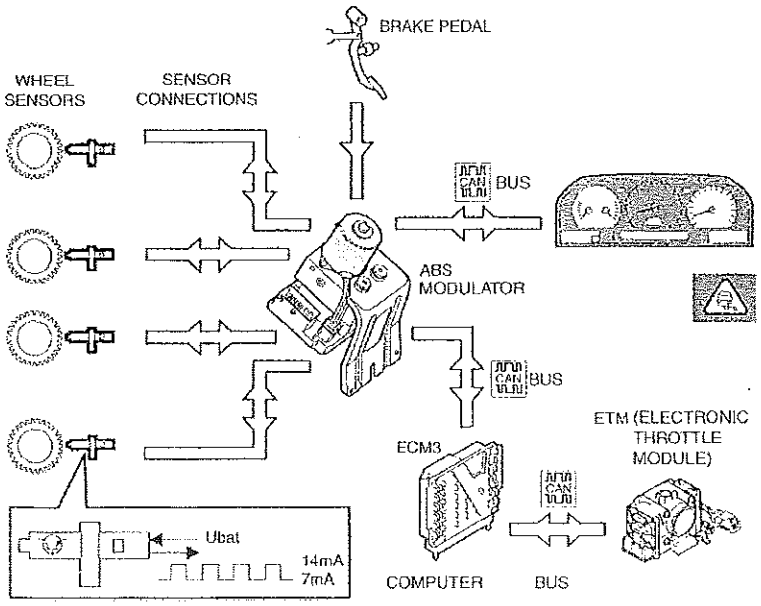

Figure Q05(a)

(b) Explain the operating principle of a traction control system and how the ABS system can be advanced to a traction control system.

(c) The configuration of a three cylinder two stroke engine is shown in figure Q05(b). Determine the magnitudes and directions of,

i) Primary forces ($\mathbf{F_P}$)
ii) Primary couples ($\mathbf{M_P}$)
iii) Secondary forces ($\mathbf{F_S}$)
iv) Secondary couples ($\mathbf{M_S}$)
v) Forces due to revolving masses ($\mathbf{F_R}$)
vi) Couples due to revolving masses ($\mathbf{M_R}$)

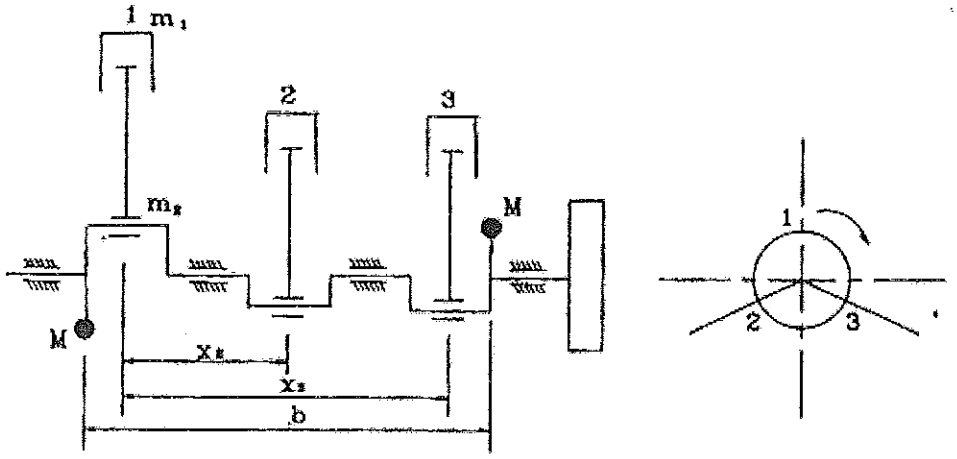

Figure Q05(b)

(d) Three main combustion systems namely: spray-guided, wall-guided and air-guided systems are used in different stratified engines, to form an ignitable mixture near spark plug at the instant of ignition. Briefly explain how the mixture is formed in each system.

Question 06 – (*20 marks*)

Figure Q06 shows an epicyclic gear box. The pinions S_1 and S_2 are driven directly from the engine by the shaft **B** and gear through pinions P_1 and P_2, with the annular wheels A_1 and A_2. These annular wheels may be locked in turn to give two speeds to the driven shaft **C**. The first speed occurs when A_1 is locked and the second speed occurs when A_2 is locked. The pinion P_2 rotates freely on a pin carried by A_1 and P_1 rotates freely on a pin carried by the arm which is keyed to the driven shaft **C**.

Assuming that the number of teeth on A_1 to be equal to that on A_2 and that the number of teeth on S_1 and S_2 to be equal, find;

i) the ratio of the number of teeth on A_1 to the number of teeth on S_1 when the second speed is 1.75 times the first speed and in the same direction.
ii) first and second gear ratio
iii) first and second speeds for this ratio when the engine speed is 3400 rev/min.

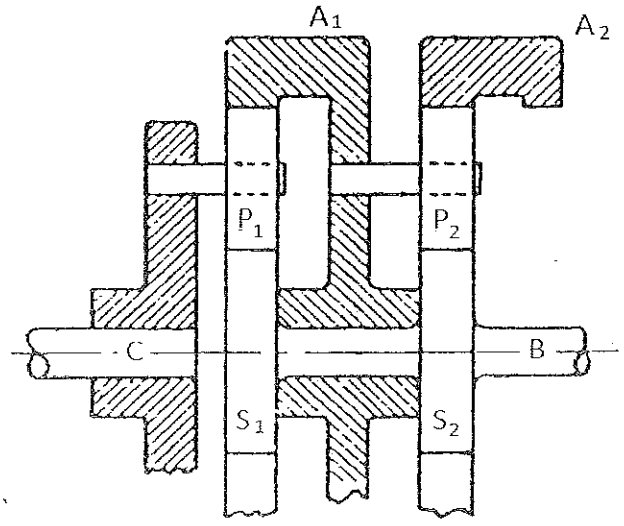

Figure Q06

Question 07 – (*20 marks*)

(a) A schematic diagram of a typical fuel cell is shown in Figure Q07. Briefly explain the operation of the fuel cell.

(b) Draw a schematic diagram for a fuel cell hybrid power train of a vehicle and identify all major components.

(c) Discuss future perspectives of fuel cell vehicles as an alternative to conventional fossil fuel based transport system in Sri Lanka.

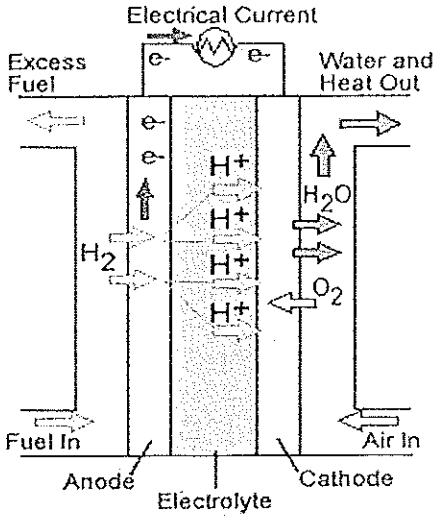

Figure Q07

(d) In GDI engines there are two basic charge modes employed; homogeneous charge and stratified charge. Briefly explain the key differences of both charge modes and their functions.