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I Semester -- 2017 – 2018
MCL 721 *AUTOMOTIVE PRIME MOVERS*
MAJOR EXAMINATION
(Open Hand-written Notes Examination)

Time: 2 hrs.

Max. Marks: 70

Problem 1: Describe the layout of a series-parallel hybrid electric vehicle. Develop the energy flow diagrams for following cases:

a. $P_{demand} > P_{engine}$
b. $P_{motor} > P_{demand} < P_{engine}$
c. $P_{motor} < P_{demand} < P_{engine}$

(10 marks)

Problem 2: A 30kW capacity electric motor is having base speed of 1600rpm and maximum speed of 6000rpm. It is found that the torque developed by the motor is inversely proportional to speed in the range of base speed to maximum speed. Draw the torque, power vs speed diagram with values of torques at base speed and maximum speed.

(5 marks)

Problem 3: Two cars with same size and same tractive resistance are running on an urban driving cycle. One car is using SI engine and the other is using an electric motor as prime movers. If these two cars travel two hours with an average power consumption of 40kW, calculate the distribution of various losses and total energy consumption in MJ for these two vehicles.

(10 marks)

Problem 4: The tractive effort demanded by a parallel hybrid vehicle is described by following equations:
Steady tractive effort demanded by vehicle (F_{SS}) :

$$0.0305V^2 + 2.2638V + 893.6$$

Where, Fss is in **Newton** and V is the velocity of the vehicle in **km/h**.

Transient Force due to Inertia (F_{IR}) is: $565.5 \times a$

Where, F_{IR} is in **Newton** and a is the acceleration of the vehicle in **m/s^2**.

This vehicle is using the electric motor described in Problem 2 as an electric prime mover and a 25 kW SI engine as the other prime mover. It is found that the engine is having maximum efficiency in the range of 2000 rpm to 3000 rpm of its crank shaft. Similarly the motor is having is maximum efficiency in the range of 2600 to 2800 rpm of motor shaft. Select most suitable gear ratios and estimate the maximum possible acceleration of the vehicle, when it is running at a speed of 45km/h. Also compute torques, powers developed by engine and motor. The wheel radius of the vehicle is 28 cm.

(20 marks)

Problem 5: The SI engine described in **Problem 4** is a four stroke engine with a compression ratio of 8.4. Estimate the work generated per cycle and specific fuel consumption at the same specified conditions of the hybrid vehicle, if the engine runs on air-standard Otto cycle. Calorific value of fuel is 41,400 kJ/kg of fuel.

(10 marks)

Problem 6: The SI engine described in **Problems 5 and 4** is to be replaced by GDI-SI engine. Select a suitable injection pressure and duration of injection and describe the structure of engine piston and cylinder for efficient and eco-friendly operation. Also explain the method of controlling the distribution of droplet size. Following are the properties of petrol at operating conditions:
Density of petrol = 734 kg/m^3; absolute (Dynamic) viscosity of petrol = 0.0005664 N-s/m^2; surface tension of petrol = 19.8×10^{-3} N/m

Develop Rosin-Rammler distribution function and evaluate the coefficients, if the size of ligament due to primary breakup of ligament is given as 90 microns.

(15 marks)