VII SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATION NOV 2017

SUBJECT: HYBRID AND ELECTRIC VEHICLES [MTE 4004]

REVISED CREDIT SYSTEM
(25/11/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Data not provided may be suitably assumed.
- Equation chart is given with the question paper.

1A.	A minivan starts on a gradient of 1:75 (on horizontal run) from rest. The curb weight = 1500N, air density = 1.275 Kg/m^2, drag coefficient = 0.775 and frontal area = 2 m^2. The rolling resistance friction fr = 0.016. Find the total resistive forces on the truck running at velocity of 40 kmph.	**4m**
1B.	A passenger car has a drag coefficient of 0.3 and a frontal area of 1.85 m^2 and is cruising at a speed of 44. 704 m/s. How much force is required to overcome aerodynamic drag if ρ = 1.27 kg/m^3. Find the ratio of aerodynamic force at velocity 40 kmph to force at velocity 44.704 m/s.	**4m**
1C.	What are the technical advantages of using electric motor as a power plant in the automobile power train?	**2m**
2A.	A series hybrid off road vehicle has to ensure the grade performance irrespective of all the odds. Design the pseudo control algorithm to be embedded in the ECU for the cases i. The peaking power source should be hence well maintained. ii. The engine temperature has to be kept in limit.	**6m**
2B.	A hybrid power plant with speed coupling through planetary gear system with gear ratio 2 is producing a power plant output speed 1200 rpm. The engine is connected to the coupler through a multigear of with gear ratio of 3. i. Find the speed of the primary power plants in following operational mode. a) Engine Alone mode b) Motor alone mode ii. Find the speed of the total power plant if a hybrid mode is activated while both the primary power plants are working at a speed of 2000 rpm .	**4m**
3A.	Find the average tractive power requirement for acceleration alone for an electric vehicle moving on paved level road that accelerates from 0 to 100 kmphr in 10 sec. The total mass: 2000 kg, aerodynamic drag area is 0.6m^2. Transmission efficiency (single gear): 98% and gear ratio 1.9 and tyre radius =0.1905m.	**3m**
3B.	Explain the control provision for Battery Management Systems Hybrid Electric Automobiles	**4m**
3C.	Calculate the power available to charge the battery in an HEV with optimal engine torque of 70Nm at a speed of 1500 rpm, torque output required at the torque coupler is 100 Nm	**3m**

	with k1 = 2 and k2 = 1. Assume η_{em} = 90% and η_{m} = 98% are the transmission efficiencies between engine and motor and the motor efficiency respectively.	
4A.	As a drive line assembly designer engineer, you have got an assignment to design an HEV power train configuration. The customer requirements are, i. Customized motor configurations. ii. Reduced emissions and improved urban cruise iii. Provision for regenerative braking iv. Judicious combination of engine and motor power while acceleration. v. Increased Electrical Transmissions and components . vi. Independent motor and engine operation. vii. Possible reductions of mechanical linkages and transmissions are encouraged. Suggest a HEV power train configuration to meet the requirements. Justify your answer.	**5m**
4B.	A Hybrid ECU has to decide between the battery alone mode or engine alone mode. The torque requirement of the road profile is given by the $= \sqrt{\frac{1}{t}\int_0^t \frac{1.41\times10^6}{3600^2} t^2 dt}$. The traction motor is a 18 Hp, 210 V, 1300 rpm series dc motor running at **constant power mode**, with combined field and armature resistance is 0.75ohms. The following are the motor constants Kv = 0.03 N-m/sq. A and Kres = 0.075 V-s/rad. If the battery capacity is 75Ahr and the period of operation extends for 1hr, with other specifications as, Tire Size - P225/60R15, Gear Reduction Ratio- 3.8, Driveline efficiency- 90%., what would be the choice of mode of operation.	**5m**
5A.	Design the hybrid power train required for the following specifications and Hence verify the gradeability. • Vehicle total mass: 1500 kg • Rolling resistance coefficient: 0.01 • Aerodynamic drag coefficient: 0.3 • Front area: 2.0 m^2 • Transmission efficiency (single gear): 98% and gear ratio 1.9 • Radius = 11 inch • Consider a safety factor of 2 for the motor for the maximum power rating. *Performance specification* • Acceleration time (from 0 to 100 km/h): 10 ± 1 s • Maximum gradeability: >30% at low speed and >5% at 100 km/h • Maximum speed: 160 km/h • Highway speed : 130 kmph	**10m**