ME 50105
Hybrid and Electric Transportation
Home Work Set 4

1. Consider a hybrid electric drivetrain with the following parameters:

Description	Requirements
Vehicle mass	1800 kg
Driver/one passenger	176 lb/80 kg
Rolling resistance coefficient, C_0	0.01
Wheel radius, r_{wh}	0.3305 m
Aerodynamic drag coefficient, C_{AD}	**0.25**
Frontal area, A_F	2.5 m^2
0–60 mi/h	8.0 s
50–70 mi/h	6.3 s
Sustained cruising speed	55 mi/h at 7% grade
Sustained cruising speed	70 mi/h at 0.5% grade
Zero emission range	5 mi at 40 mi/h

Additional parameters are: ρ_{air} = 1.16 kg/m^3, g = 9.8 m/s^2, maximum cruising speed = 150 kph, transmission efficiency = 0.92, motor & generator efficiency = 0.95, and f_s = 0. C_0 is same as f_0.

i. Design a series hybrid vehicle powertrain based on the above performance requirements (i.e. specify engine and motor power ratings, transmission ratio, battery power rating and energy capacity).
ii. Use FTP 75 urban and FTP 75 highway drive cycles and the software ADVISOR 3.0 to verify your design via simulation.
iii. Provide the following:
    a. Plot traction motor torque/power vs speed;
    b. Plot acceleration time vs vehicle speed;
    c. Plot tractive effort and resistance vs vehicle speed at various grades;
    d. Plot gradeability vs vehicle speed;
    e. Plot engine power vs. vehicle steady state speed on flat and 5% grade;
    f. Plot engine torque vs speed with BSFC contour for both urban and highway cycles.
iv. Also plot the following variable for both urban and highway cycles:
    a. vehicle power
    b. motor power
    c. engine power
    d. battery power, and
    e. battery SoC.

2. For the vehicle parameters and performance requirements in problem 1,
    i. Design a parallel HEV drivetrain providing
        (a) Engine power,
        (b) Transmission ratio,

(c) Electric motor power,
(d) Battery power rating, and
(e) Battery energy capacity.

ii. Use FTP 75 urban and FTP 75 highway drive cycles and the software ADVISOR 3.0 to verify your design via simulation.

iii. Provide the following plots:
(a) Engine power vs. vehicle steady state speed on flat and 5% grade;
(b) Engine torque vs speed with BSFC contour for both urban and highway cycles;
(c) Traction motor torque/power vs speed;
(d) Acceleration time vs vehicle speed;
(e) Tractive effort vs vehicle speed at various grades;
(f) Energies drawn from battery and engine vs vehicle speed during acceleration.

iv. Also plot the following variables for both urban and highway cycles:
(a) vehicle power,
(b) motor power,
(c) engine power,
(d) battery power, and
(e) battery SoC.