

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 6

LEFEL 6

EXAMINATION PERIOD
MAY 2018

CYFNOD ARHOLIADAU
MAI 2018

MODULE CODE: M3X8668
ELECTRIC AND HYBRID PROPULSION CONTROL

TIME: 2 HOURS

ANSWER TWO QUESTIONS OUT OF THREE

Equipment or materials required – Calculators

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ANSWER TWO QUESTIONS OUT OF THREE

1. First Exam Question



The Post Office have decided to investigate the advantages of employing hybrid technology on their urban delivery and collection vans. They hope to gain the following improvements:

- Reduced fuel consumption
- Lower emissions
- Reduced running costs
- A greener image
- Possible silent running capability for early morning deliveries.

- a) Analyse alternative hybrid vehicle architectures
(2 marks)
- b) Investigate and contrast alternative technologies for
 - 1. Combustion engine
 - 2. Energy storage
 - 3. Transmission and driveline
 - 4. Drive / electrical machine**(6 marks)**
- c) Develop a brief typical drive cycle
(2 marks)
- d) Recommend a Post Office Hybrid Urban Delivery Van solution and demonstrate how it may meet their requirements
(10 marks)

2. Second Exam Question



A Black Cab Taxi vehicle has the following characteristics.

Mass 2000kg

Frontal area 3m^2

Coefficient of drag (CD) 0.5

Density of air = 1.2kg/m^3

The rolling (force) resistance of a tyre on asphalt $R_F(\text{newtons}) = 0.016N$ per applied N of vertical force.

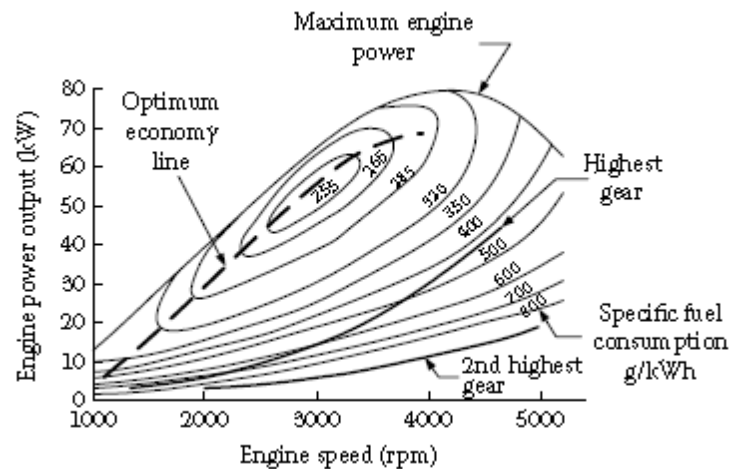
The vehicle is equipped with a mechanical flywheel battery kinetic energy recovery system (KERS). Assume the electrical system is 100% efficient in both directions. The vehicle begins its journey from the Cadogan Building down Mount Pleasant hill with a stationary flywheel.

The vehicle descends through a vertical drop of 30m along 400m of road at a constant speed of 40kph. Assume the vehicle captures all of the available energy and the vehicle friction brakes are not applied.

- How much energy is stored by the flywheel at the bottom of the hill?
(8 marks)
- If the vehicle turns left and continues at the same speed along level ground how far will it travel before the energy in the flywheel has been exhausted?
(4 marks)
- A similar vehicle is equipped with a similar KERS device. The flywheel has been specified to store 400Kj of energy.
The device has a maximum rotational speed of 10,000rpm
Packaging dictates that the disc can be no larger than 0.4 m outer diameter
Calculate the dimensions and mass for a suitable solid (plain section) flywheel?
Density of steel = 7820 kg/m^3
(3 marks)
- Discuss power transmission problems from the road wheels to a flywheel storage device. Suggest and analyse possible solutions to overcome these problems. Use diagram and example calculations to support your discussion.
(5 marks)

3. Third Exam Question

An internal combustion engine has a typical fuel consumption map as shown.



The lowest specific fuel consumption is indicated on the above map.

1. Explain why the specific fuel consumption increases when moving away from the best specific fuel consumption point by:
 - a) Increasing the power/load required at the same rpm value
 - b) Increasing the rpm at the same power/load value
 - c) Reducing the power/load required at the same rpm value
 - d) Reducing the rpm at the same power/load value

(4 marks)

2. Explain how exhaust gas recirculation can be used to improve internal combustion engine efficiency at low load. Use diagrams and graphs (pressure-volume and pressure crank angle) to explain:
 - a) The lack of efficiency at low power/load conditions.
 - b) How EGR can help to improve efficiency?
 - c) What advantage or disadvantages are associated with EGR systems?

(8 marks)

3. Explain how power-stroke over expansion can be used to improve engine efficiency

Use diagrams and graphs to explain:

 - a) Limitations of the otto cycle and the lack of efficiency.
 - b) How can over expansion improve efficiency?.
 - c) Explain two technology solutions for achieving over expansion.

(8 marks)

Equations

Potential Energy = mass x gravity x height $PE = m.g.h$

Moment of Inertia = mass x (radius of gyration)² $I = mk^2$

For a plain disc : radius of gyration $k = \text{outer radius} \times 0.707$

Aero dynamic resistance = $0.5 \times \text{area} \times cd \times \text{density of air} (1.2 \text{ kg/m}^2) \times \text{velocity}^2$

	Linear Motion		Rotational Motion
Position	x	θ	Angular position
Velocity	v	ω	Angular velocity
Acceleration	a	α	Angular acceleration
Motion equations	$x = \bar{v}t$	$\theta = \bar{\omega}t$	Motion equations
	$v = v_0 + at$	$\omega = \omega_0 + \alpha t$	
	$x = v_0t + \frac{1}{2}at^2$	$\theta = \omega_0t + \frac{1}{2}\alpha t^2$	
	$v^2 = v_0^2 + 2ax$	$\omega^2 = \omega_0^2 + 2\alpha\theta$	
Mass (linear inertia)	m	I	Moment of inertia
Newton's second law	$F = ma$	$\tau = I\alpha$	Newton's second law
Momentum	$p = mv$	$L = I\omega$	Angular momentum
Work	Fd	$\tau\theta$	Work
Kinetic energy	$\frac{1}{2}mv^2$	$\frac{1}{2}I\omega^2$	Kinetic energy
Power	Fv	$\tau\omega$	Power

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