EE4001 Quiz 1: Mechanical Systems and DC Machines

Student Name: **Student Number:**

1. Calculate the regenerative energy recoverable when a flywheel of inertia 0.06 kgm^2 slows from 1500 rpm to 750 rpm.

2. If a 1 m diameter windmill generates 500 W of power, what approximate power level might a 10 m windmill develop: (a) 1.5 kW, (b) 5 kW, or (c) 50 kW?

3. Sketch a plot of power vs. speed for a constant-torque load.

4. An electric vehicle has the following attributes: mass M = 500 kg, wheel diameter d_W = 1m, gear ratio from rotor to drive axle n = 10, and a nominal gear efficiency of 95%. The vehicle is required to *decelerate* from 36 to 0 km/hr in 10 s on a flat road surface under calm wind conditions. Neglecting load forces, instantaneously at 18 km/hr calculate the regenerative torque to the electric motor to achieve this braking.

5. Calculate the regenerative power in horse power for the above condition.

6. Despite the relatively low service life of dc brushed machines, what are some of the reasons for their common use?

7. Sketch a plot of torque vs. angle for a primitive two-pole dc motor with an armature winding consisting of 4 coils wave wound.

8. A permanent magnet of length l cm is placed in a magnetic circuit with an airgap of 0.2 cm. Assuming a high permeability core and a uniform cross-sectional area, what is the magnet field strength H_m when the magnet flux density B_m is 0.3 T?

9. Derive the torque-speed characteristic equation for a dc machine.

10. A permanent magnet dc motor has the following parameters: Ra = 0.25 Ω, k = 0.5 in MKS units. Calculate the speed in rpm at an applied voltage of 100 V and torque of 10 Nm.

11. How can armature reaction be compensated to minimize its effects?

12. A permanent-magnet dc motor is known to have an armature resistance of 1Ω. When operated at no load from a dc source of 50 V, it is observed to operate at a speed of 1200 rpm and to draw 1 A. Find the motor constant.

13. Sketch together the induced emf and phase current in regenerative mode for a single phase of a three-phase trapezoidal-waveform electronically-commutated motor.

14. An EC dc motor is sourced by a 50 V supply, and pulls 10 A from the source. The phase-phase resistance is 0.5Ω. The output speed is 5000 rpm. What are the output torque and machine efficiency, neglecting core, friction, and windage losses?