Name: **Student Number:**

1. A 10 kg mass is hung from the tip of a lever. The lever is 1 m long and is at a 60^o angle to the ground. Calculate the holding torque required to keep the lever from turning.

2. Given that a solid metal cylinder has radius r = 10 cm, length l = 20 cm, and material density $\rho = 10 \times 10^3$ kg m^{-3}, calculate its moment of inertia.

3. A motor is rigidly coupled to a load and each structure has an inertia of 0.05 kgm^2. Calculate the required electromagnetic torque if the speed is to increase linearly from rest to 600 rpm in 2π seconds.

4. An electric vehicle has the following attributes: drag co-efficient C_W = 0.2, vehicle cross section A = 3 m^2. Use density of air ρ_{air} = 1.2 kg m^{-3}. Instantaneously at a vehicle speed of 36 km/hr, calculate the aerodynamic drag when driving into a 3.6 km/hr headwind.

5. 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 accelerate from 0 to 36 km/hr in 10 s on a flat road surface under calm wind conditions. Neglecting load forces, instantaneously at 18 km/hr calculate the electromagnetic torque from the electric motor to achieve this acceleration torque

6. A vehicle experiences a drag force of 400 N at 36 km/h. If the wheel diameter is 0.6 m. Calculate the torque required at the axle to overcome the drag.

7. At highway speed, the power generated by car engines is mostly used to overcome aerodynamic drag, and thus the fuel consumption is nearly proportional to the drag force on a level road. Determine the percentage increase in fuel consumption of a car per unit time when a person who normally drives at 55 mph now starts driving at 70 mph.

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

9. Sketch a plot of torque vs. angle developed by a rotating armature conductor in a primitive two-pole dc motor.

10. What are the two standard winding configurations for the armature of a dc motor, the purpose of which is to reduce torque ripple?

11. A motor runs at 1000 rpm when supplied by 100 V at no load. Under full-load current of 10 A, the field flux is weakened by 5 % due to armature reaction. Calculate the full-load speed when the armature resistance is 0.5 Ω .

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

13. In a series or universal motor, how much will the torque increase when the current is doubled?

14. A permanent magnet dc motor has the following parameters: Ra = 0.25 Ω , $k_E = k_T = 0.5$ in MKS units, moment of inertia J_m = 0.02 kgm^2. The motor is accelerating a load of inertia 0.08 kgm^2 at 10 rad/s^2. Calculate the armature current and applied voltage instantaneously at 100 rad/s.

15. A permanent-magnet dc motor is known to have an armature resistance of 1 Ω . 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.

16. Sketch the induced emfs in the trapezoidal-waveform electronically-commutated motor.