# KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
## ELECTRICAL ENGINEERING DEPARTMENT
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**EE-360**

Quiz 4 ser#: I.D.: Name:

A 20-hp 240-V series dc motor has an internal series resistance $R_A + R_s$ equal to 0.25 ohm. At full load, it draws 80 A and runs at 750 r/min. What is the efficiency of the motor at full-load conditions.

Solution:

(a) At full load, the internal generated voltage of this motor is

$$E_A = V_T - I_A(R_A + R_S)$$

$$E_A = 240\ V - (80\ A)(0.25\ \Omega) = 220\ V$$

The output power of the motor is

$$P_{OUT} = (20\ hp)(746\ W/hp) = 14920\ W$$

The input power to this motor is

$$P_{IN} = V_T I_L = (240\ V)(80\ A) = 19200\ W$$

The efficiency of this motor at full load is

$$\eta = \frac{P_{OUT}}{P_{IN}} \times 100\% = \frac{14920\ W}{19200\ W} \times 100\% = 77.7\%$$

(b) At 30 A, the flux is 52% of the full-load flux, so the internal generated voltage $E_{Ao}$ at a speed of 750 rev/min will be

$$E_{Ao} = (0.52)(220\ V) = 114.4\ V$$

The actual internal generated voltage is

$$E_A = V_T - I_A(R_A + R_S) = 240\ V - (30\ A)(0.25\ \Omega)$$

$$E_A = 232.5\ V$$

The actual speed of the motor when it is drawing 30 A is

$$n = \frac{E_A}{E_{Ao}}\, n = \frac{232.5\ V}{114.4\ V}\ (750\ rev/min) = 1524\ rev/min$$