King Fahd University of Petroleum & Minerals
Electrical Engineering Department

EE-360 DESIGN PROJECT

Semester 132

This project is due on May 12, 2014

It is required to design a shunt-excited DC motor for hoisting drive in industrial overhead crane system with 20-ton lifting capacity. This application requires constant torque operation. The motor sizing depends on two vertical forces: the weight (mass x gravity) of the maximum load plus hook represent one vertical force component and the second component is that same weight with frictional coefficient applied to it. The following equation can be used to calculate the power required to hoist 20-ton load (including hook mass) at constant speed of 5 m/min

$$P_{hoist} = \frac{(m_L + m_L \rho) \times g \times v}{1000 \times 60 \times \eta_T \times \eta_m}$$

P_{hoist} : hoist power (kW)
m_L : mass of the load + hook (kg)
ρ : coefficient of frictional resistance (typical 0.5)
g : gravity (9.81 m/s)
v : hoist motion speed (m/min)
η_T : transmission efficiency (typical 0.9)
η_m : motor efficiency

Design the motor so that the output power of the motor is expected to be 10 (plus your two digits serial number)% higher than the calculated hoisting power. Assume initially that the motor efficiency is 92 (plus your one digit section number)%.

The copper losses including the brush losses at full load should be 2% of the output power. The no load power should not exceed 5% of the output power. The motor speed is 1200 rpm. The terminal voltage is 220V. The brush voltage drop is 2V each.

The magnetization curve is linear and given as $\Phi = 0.01 \times I_f$. The flux per pole should not exceed 25 mWb. The number of poles is up to 8 poles and assume duplex lap-wound armature. The armature resistance should be 0.20 Ω.

Explain all your design steps and determine the followings:

output power P_{out} , output torque T_{out} , developed power P_{dev} , developed torque T_{dev} , induced voltage E_A , machine constant K, number of conductors Z , current per path I_{path} , input (terminal) current I_t , armature current I_A, field current I_f , field resistance R_f , rotational losses P_{rot} , copper losses P_{cu} , input power P_{input} , actual motor efficiency η_m