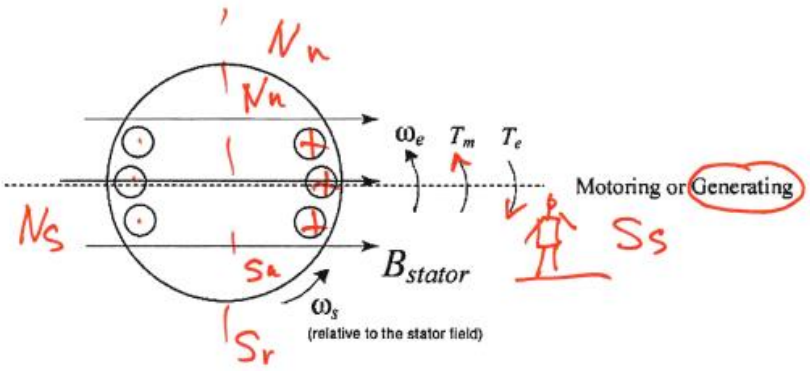
ELEC 342: Quiz 3 **Solution** **March 20, 2026**

Name: _____ Student ID: _____

Close notes and books. No Calculators. You have 20 minutes: No cheating (zero mark if turned in late).

Q1 (40pts): Assume a conventional squirrel-cage 2-pole **Induction Machine** with magnetic field B_{stator} that rotates in the **counterclockwise** (CCW) with the speed ω_e as shown. The rotor bars (rotor winding conductors) shown as small circles. An external mechanical torque T_m is applied to the shaft in such a way that rotor bars move **counterclockwise** (CCW) **relative to the stator rotating field**. On this figure:

(a) (10pts) Label and/or show the magnetic poles on the stator ***Ns*** and ***Ss,*** respectively
(b) (10pts) Show the current direction in the rotor bars using "dot" and "+" in each conductor
(c) (10pts) Label and/or show the magnetic poles on the rotor ***Nr*** and ***Sr,*** respectively
(d) (10pts) Show the direction of torques T_m and T_e (draw an arrow in CW or CCW) and identify the mode (circle ***Motoring*** or ***Generating***)



Q2 (30pts): A conventional squirrel-cage **Induction Machine** is supplied from a 60 Hz AC source. **Circle one number *or* comment:**

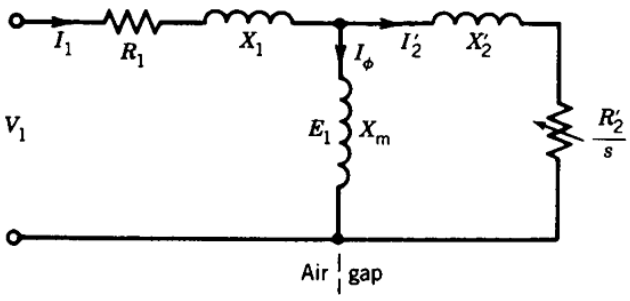
a) What would be the most likely **nominal motor** speed in **rpm** if the machine has **2** poles?
3750 3600 **3450** 1850 1800 1750 1250 1200 1150 935 900 850 750 720 680

b) What would be the most likely **nominal generator** speed in **rpm** if the machine has **3** poles? **Not possible!**
3750 3600 3450 1850 1800 1750 1250 1200 1150 935 900 850 750 720 680

c) What would be the most likely **nominal generator** speed in **rpm** if the machine has **4** poles?
3750 3600 3450 **1850** 1800 1750 1250 1200 1150 935 900 850 750 720 680

Q3 (15pts): Sketch the **Full Equivalent Circuit** of an induction machine and **label** all circuit components (including input voltage V_1 and air gap). Then indicate which parameters can be determined by (a) DC measurement test (e.g., multimeter test), (b) no load test, and (c) blocked rotor test, respectively. You need to be very specific about which test determines which parameter(s) – you cannot simply state "test X determines resistance". **You need to state exactly which component(s) each test determines on your equivalent circuit.**

(a) **DC measurement test**: determines R_1
(b) **No load test**: determines combined reactance $X_{NL} = X_1 + X_m$. Optional answer: rotation losses.
(c) **Blocked rotor test**: determines $R_{BR} = R_1 + R_2'$, $X_{BR} = X_1 + X_2'$. Optional answer: we can combine the results from DC measurement test, no load test, and blocked rotor test to determine R_2' and X_m by assuming $X_1 \approx X_2'$.



Q4 (15pts): What are the two requirements needed to produce an MMF vector F_s that has a constant magnitude and rotates in space? What is the minimum number of phases you need?

Need (a) a set of AC currents shifted in time and (b) a set of stator windings shifted in space. Minimum number of phases needed is 2.