

ECE370 MACHINES & POWER

Test # 2, Spring 2008 - 2009

Name _____

Box # _____

Attempt all four questions.

Use ***Polar*** notation and state magnitudes to 3 sig. figures.

No partial credit unless you explain your solution procedure.

Write in the space below the question, and on the page facing the question.

Calculators and an 8½ x 11 sheet (both sides) permitted.

Time Allowed - One 50 min. Period.

Question #	Possible Points	Awarded Points
1	25	
2	25	
3	25	
4	25	
Total	100	

1.

A single-phase transformer is rated, 6 MVA, 14.4 kV/480 V, and has the following data from tests that were conducted on the high voltage side:

Short-circuit test: $V = 1.27 \text{ kV}$, $I = 420 \text{ A}$, $P = 160 \text{ kW}$

Open-circuit test: $V = 14.4 \text{ kV}$, $I = 32 \text{ A}$, $P = 140 \text{ kW}$

- a) Determine the approximate equivalent circuit w.r.t the hv side, i.e. draw the circuit and insert the parameter values.
- b) Estimate the efficiency if 4.8 MVA is supplied at 0.7 lag pf.
- c) Determine the voltage regulation for the conditions in (b).

a)

$$R_c = \frac{14400}{9.722} = 1481 \Omega$$

and:

$$X_m = \frac{14400}{30.49} = 472.3 \Omega$$

$$R = 0.907 \Omega \text{ and } X = 2.885 \Omega$$

b) $\eta = 93.3\%$.

c) $VR = 6.28\%$.

2.

The following information is taken from the nameplate of a separately-excited dc generator.

Armature:	240 kW,	1200 V,	0.3 Ω .
Field:		240 V,	10 A

At its rated speed of 2300 rpm the no-load torque is measured at 50 Nm. Ignore armature reaction and magnetic saturation.

a) For rated load conditions determine:

- i) Rated Shaft Horsepower
- ii) Rated Efficiency
- iii) Load Impedance

b) Determine the terminal voltage, kW output and the efficiency if the field current is reduced to 4 A and the speed is increased to 2875 rpm, causing the rotational losses to become 25 kW. The load impedance is unchanged.

a) i) $P_{\text{shaft}} = 354 \text{ hp.}$

ii) $\eta = 90.08\%.$

ii) $R_L = 6 \Omega.$

b) $V' = 600 \text{ V.}$

$\eta = 67.4\%.$

3.

A 600 V dc series motor is rated at 250 hp, 2000 rpm. It has an armature resistance of 0.1Ω and a field resistance of 0.05Ω . It draws a current of 360 A from the supply when delivering rated load. Ignore magnetic saturation and determine:

- a) Rated output torque.
- b) Rated developed torque.
- c) Rated efficiency.
- d) Rotational losses at rated speed.
- e) Speed when the load is changed, causing the line current to drop to 180 A.
- f) Developed torque for the conditions in part (e).
- g) Horsepower output for the conditions in (e) if the rotational losses are proportional to speed².
- h) Efficiency for the conditions in part (e).

a) $T_{\text{out}} = 890.5 \text{ Nm} .$

b) $T_D = \boxed{938.5 \text{ Nm} .}$

c) $\eta = \boxed{86.3 \%} .$

d) $P_{\text{rot}} = \boxed{10.06 \text{ kW} .}$

e) $\boxed{n' = 4198 \text{ rpm}}$

f) $T_D' = \boxed{234.6 \text{ Nm} .}$

g) $P'_{\text{out}} = \boxed{78.85 \text{ hp} .}$

h) $\eta = \frac{58.82}{108} \times 100\% = \boxed{54.46 \%} .$

4.

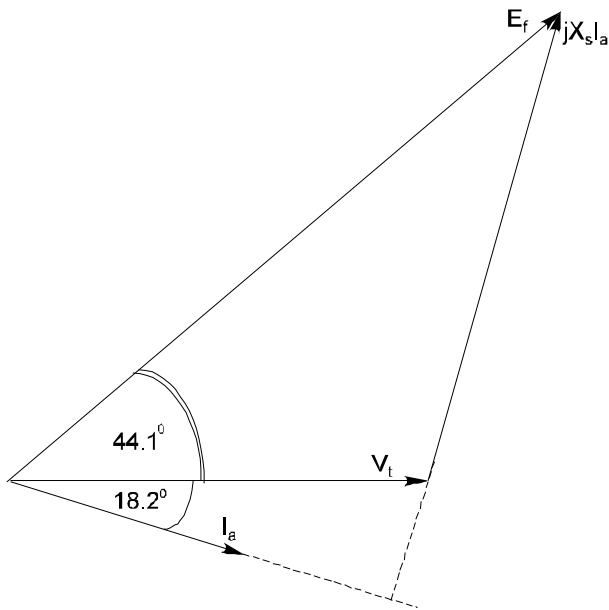
A 500 MVA, 20 kV, 4 pole, synchronous generator has a synchronous reactance of 1.2Ω . The per-phase excitation voltage is determined by $|E_f| = 85 I_f$. Determine:

- The load angle (δ) when rated load is supplied at rated voltage and 0.95 **lagging**.
- The field current required.
- The phasor diagram.
- Shaft torque if the overall efficiency is 93%
- If you neglect saturation, what is the %VR?

a) $\delta = 44.1^\circ$

b) $I_f = 278 \text{ A}$

c)



d) $T_{in} = 2.71 \text{ MNm}$

e) $VR = 104.6\%$