UNIVERSITY OF TASMANIA
[Australian Maritime College]

EXAMINATIONS FOR DEGREES AND DIPLOMAS

October-November 2010

JEE486 Marine Electrical Powering and Systems

First and only paper

Examiner: Dr. Hung Nguyen

Time Allowed: THREE (3) hours

Instructions:
- There are six (6) questions. Attempt all questions.
- Students are permitted to use non-programmable calculators, lecture notes, prescribed text and recommended reference books in this exam. No worked tutorial problem notebooks are permitted.
Question 1

(a) Write the KVL and KCL equations for the circuits in Figures 1(a) and 1(b):

(b) A 8.1 kV source delivers power to a 30 Ω resistor and a 500 kW electric motor as shown in Figure 2. Draw the equivalent per-unit diagram.

Use the following base values:

\[ E_b = 3 \text{ kV}, \quad I_b = 150 \text{ A}; \quad P_b = 450 \text{ kW} \quad \text{and} \quad Z_b = 20 \Omega \]

[6 marks]

continued...
Question 2

(a) Describe two (2) methods that can be used to vary the speed of a dc motor. You may use simple sketches or formulae to illustrate your answers.

[4 marks]

(b) We wish to stop a 120 hp, 240 V, 400 rpm motor by using the dynamic braking circuit shown in Figure 3.

If the nominal armature current is 400 A, calculate the following:

(i) The value of the braking resistor R if we want to limit the maximum braking current to 125% of its nominal value.

(ii) The baking power [kW] when the motor has decelerated to 200 rpm, 50 rpm and 0 rpm.

[4 marks]
Question 3

(a) A 13.2 kV, 60 Hz single-phase line connects a substation to an industrial load. The line has a resistance of 2.4 Ω and a reactance of 12 Ω. The metering equipment at the substation indicates that the line voltage is 12.5 kV and that the line is drawing 3 MW of active power and 2 Mvar of reactive power. Calculate the:
   (i) current flowing in the line;
   (ii) active and reactive power consumed by the line;
   (iii) active, reactive and apparent absorbed by the load; and
   (iv) voltage across the load.

[4 marks]

(b) A circuit composed of a 12 Ω resistor in series with an inductive reactance of 5 Ω carries an ac current of 10 A. Calculate the:
   (i) active power absorbed by the resistor;
   (ii) reactive power absorbed by the inductor;
   (iii) apparent power of the circuit; and
   (iv) power factor of the circuit.

[4 marks]

Question 4

(a) A 3-phase heater dissipates 15 kW when connected to a 208 V, 3-phase line.
   (i) What is the line current if the resistors are connected in wye (star)?
   (ii) What is the line current if the resistors are connected in delta?
   (iii) If the resistors are known to be connected in wye, calculate the resistance of each?

[4 marks]

(b) A 60 hp 3-phase motor absorbs 50 kW from a 600 V, 3-phase line. If the line current is 60 A, calculate the:
   (i) efficiency of the motor;
   (ii) apparent power absorbed by the motor;
   (iii) reactive power absorbed by the motor; and
   (iv) power factor of the motor.

[4 marks]

continued...
Question 5

(a) A 3-phase, 20-pole induction motor is connected to a 600 V, 60 Hz source.

   (i) What is the synchronous speed?
   (ii) If the voltage is reduced to 300 V, will the synchronous speed change?
   (iii) How many groups are there, per phase?

   [4 marks]

(b) An open-circuit voltage of 240 V appears across the slip-rings of wound-rotor induction motor when the rotor is locked. The stator has 6 poles and is excited by a 60 Hz source.

   If the rotor is driven by a variable-speed dc motor, calculate the open-circuit voltage and frequency across the slip-rings if the dc motor turns at:

   (i) 600 rpm, in the same direction as the rotating field;
   (ii) 900 rpm, in the same direction as the rotating field; and
   (iii) 3600 rpm, opposite to the rotating field.

   [4 marks]
Question 6

(a) An ac source having an effective voltage of 600 V, 60 Hz is connected to a single-phase bridge rectifier as shown in Figure 4:

![Diagram of a single-phase bridge rectifier with peak voltage equal to E_m.]

Figure 4.

The load resistor has a value of 30 Ω. Calculate the:

(i) dc voltage $E_{3a}$
(ii) dc voltage $E_{5a}$, and
(iii) dc load current $I$.

[4 marks]

continued...
(b) The converter shown in Figure 5 is connected to a transformer that produces a secondary line voltage of 40 kV, 60 Hz. The load draws a dc current of 450 A. If the delay angle is 75°, calculate the:

(i) dc output voltage;
(ii) active power drawn from the ac line;
(iii) effective value of the secondary line current; and
(iv) reactive power absorbed by the converter.

Figure 5.

[4 marks]