Electrical Engineering Department
I.I.T. Delhi

EEL101-Fundamentals of Electrical Engineering

Major Exam. Part I (27-11-2006) **Total Marks: 20** **Time: 20 minutes (sharp)**

Name: ..... Entry No.....

Note:- (i) Answer all questions. (ii) No clarifications on questions.
(iii) Assume data if any required.
(iv) **Wrong answers will attract 50% negative marks.**

I. Tick mark the most accurate answer: **[10marks]**

(1) Which of the following motor can have equal number of teeth on its stator and rotor:
[A] Permanent magnet stepper motor [B] Three-phase A. C. reluctance motor
[C] Hysteresis motor [D] Induction Motor
[E] None of the above

(2) Switched Reluctance Motor can have the following drive circuit configuration:
[A] 2-Phase Unipolar [B] 2-Phase Bipolar
[C] 3-Phase Unipolar [D] [B] & [C] above

(3) Following combination of stator and rotor teeth are not possible in a switched reluctance motor:
[A] 12 : 10 [B] 8 : 6 [C] 8 : 4 [D] 6 : 4

(4) The reluctance torque in a VR stepper motor is:
[A] independent of the direction of the current and the variation in the inductance of the phase winding
[B] dependent on the direetion of the current but independent of the variation in the inductanee of the phase winding
[C] independent of the direction of the current but dependent of the variation in the inductance of the phase winding
[D] dependent of the direction of the current and the variation in the inductance of the phase winding

(5) The stepper motor:
[A] can have a D.C. winding on the rotor
[B] rotor can be made out of soft magnetie material without any slots cut on it
[C] can have squirrel-cage winding on the rotor
[D] ean have salient pole permanent magnets on the rotor

(6) In a linear electromagnetic circuit, the following is true:
[A] field energy and co-energy are same [B] field energy is greater than co-energy
[C] field energy is less than co-energy [D] co-energy is zero

(7) In rotating electrical machines, if the self-inductances of stator and rotor windings are constant, then the following torque component is absent:
[A] synchronizing torque [B] starting torque
[C] hysteresis torque [D] reluctance torque

(8) In which of the following motor, the relative speed between stator and rotor magnetic field is not zero:
[A] synchronous motor [B] induction motor
[C] reluctance motor [D] none of the above

(9) A two-phase bipolar drive circuit configuration will be all right for the following motor.
[A] Variable Reluctance Stepper motor [B] PM stepper motor
[C] Switched Reluctance Motor [D] None of the above

(10) The SRM has a:
[A] PM rotor [B] Soft magnetic Rotor [C] PM stator [D] Hybrid Rotor

II. Write down your answers in one or two sentences **[6marks]**

(1) What is the major disadvantage of a PM motor?

(2) What is the important advantage of an axial flux PM BLDC motor?.

(3) What is the basic difference between an SRM and a VR Stepper Motor?

(4) What is the use of Z-parameters of a two-port network?

(5) Draw an integrator circuit using an OPAMP.

(6) Draw a voltage follower circuit using an OPAMP.

III. Fill in the missing word/words: **[4 marks]**

(1) In a linear magnetic circuit, the field energy is equal to the energy stored in the magnetic field and the coenergy equal to the energy stored in the ....

(2) The input and output impedances of an OPAMP respectivcly are ..... and .....

(3) The electrical machine, which can be represented by a two-port network. is .....

(4) The steady state response of R-L series circuit and R-C circuit for a step input of voltage V, respeetivcly are ..... and .....

Eleetrical Engineering Department
I.I.T. Delhi

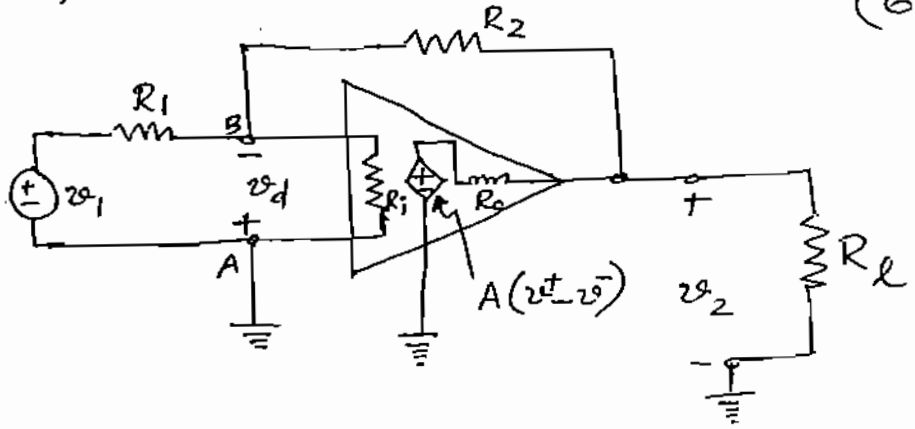
EEL101-Fundamentals of Electrical Engineering

Major Exam. Part II (27-11-2006) **Total Marks: 100** **Time: 100 minutes (sharp)**

Name: ..... Entry No.....

Note:- (i) Answer all questions.
(ii) No elarifieations on questions exeept for printing mistakes, if any.
(iii) Assume data if any required.
(iv) **No negative marks.**

1) In figure given below, $R_1 = 15\ k\Omega$, $R_2 = 45\ k\Omega$, $R_o = 0$ $R_i = 400\ k\Omega$, and $A = 10^4$. Find v_2/v_1. Assume the amplifier is not saturated. (6 marks)

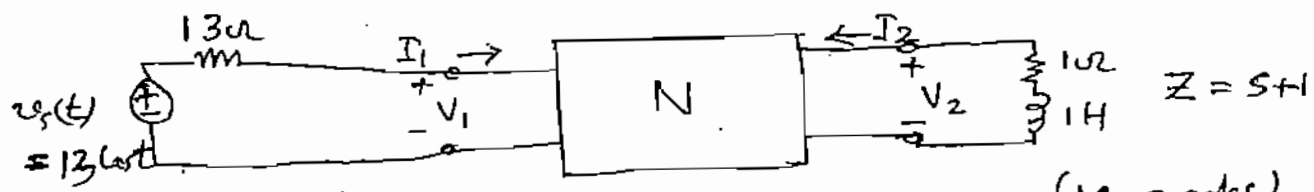


2) Design a circuit using OPAMPs with $x(t)$ as input to generate output $y(t)$ which satisfies the the following equation:

$$2y''(t) - y'(t) + 5y(t) = x(t)$$

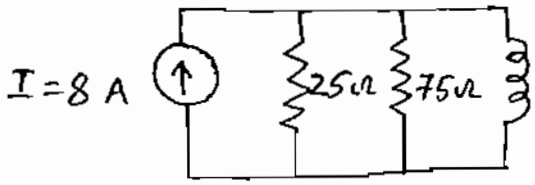
(10 marks)

3) The Z-parameters of a two-port network are given by: $Z_{11} = 3s + 1/s$, $Z_{12} = Z_{21} = 4s$, $Z_{22} = 4s + 2$ The network is connected to a source and load as shown below. Find I_1, I_2, V_1 and V_2.



(10 marks)

4) Assuming the coil initially deenergized and the current source suddenly applied to the circuit, find the total expression for the current through the energy storing element.



(10 marks)

5) The $\lambda - i$ relationship for an electromagnet system is given by:

$$\lambda = \frac{1.8\, i^{1/3}}{g}$$

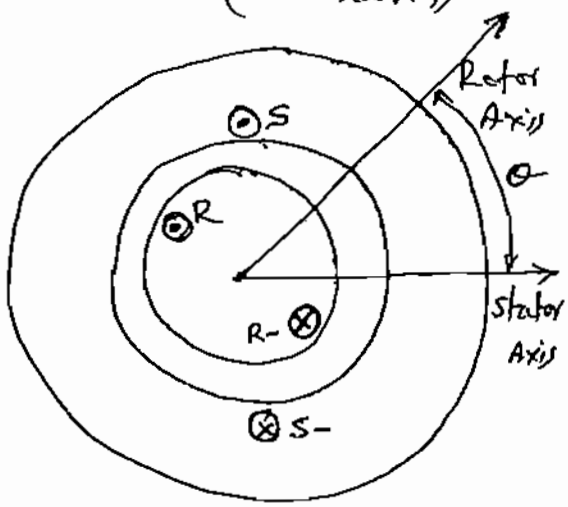
where g is the airgap length. For a current $i = 3$ A, and $g = 1$ mm, determine the mechanical force on the moving part.

(a) Using the field energy of the system
(b) Using the coenergy of the system

(6 marks)

6) The rotating machine shown in the figure has the following parameters.

$L_{ss} = 0.19$ H, $L_{rr} = 0.08$ H,
$L_{sr} = 0.09 \cos\theta$ H



(a) The rotor is driven at 3000 rpm. If the stator winding carries a current of 7 A (rms) at 50 Hz, determine the instantaneous voltage and rms voltage induced in the rotor coil. Determine the frequency of the rotor induced voltage.

$\theta = \omega_m t + \delta$

(12 marks)

7) A 10 KW, 100V, 1200 rpm DC shunt generator has an armature resistance $R_a = 0.15\ \Omega$, shunt field winding resistance $R_f = 85\ \Omega$, and the number of turns/pole is 1000. ~~The rated~~ Determine the full load efficiency and the terminal voltage at full load. (6 marks)

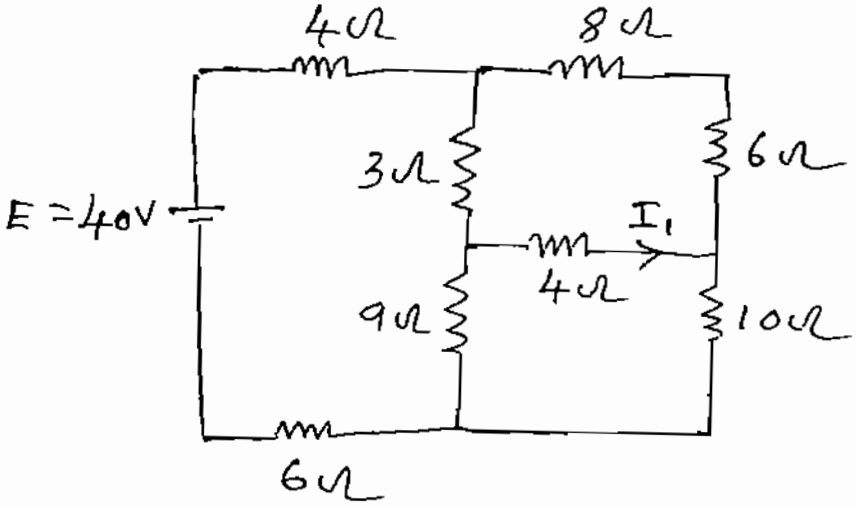
8) Design the stator and rotor poles/slots combinations for a doubly-~~slotted~~ salient reluctance motor with a step angle of 22.5°. If the $\frac{dL}{d\theta} = 1.5$ mH/radian, Calculate the torque developed for a phase current of 10A. Show the motor sketch and suggest appropriate drive circuits and justify its operation in both the directions by indicating the switching sequence. (10 marks)

9) A 1-Phase, 20 KVA, 220/440 V, 50 Hz Transformer gave the following test results:

Open Circuit Test (440V side Open): 220V, 8A, 600W
Short Circuit Test (220 V side shorted): 30V, 50A, 900W

(a) Derive the approximate equivalent circuit parameters and draw the equivalent circuit.
(b) Determine the voltage regulation at ~~full~~ load, 0.8 PF lagging.
(c) Determine the maximum efficiency of the transformer, and at what load this will occure.

10) In the circuit shown below, (a) find the current delivered by the battery and (b) find the current I_1 through the 4Ω resistance.



(10 marks)

12) Write down the types of stators (structure and winding) and rotors (structure and winding) that can be used in the following motors.

(a) Permanent magnet Stepper motor

(b) Three-Phase Synchronous Motor

(c) Three-Phase Induction Motor

(d) Switched Reluctance Motor

(4 marks)

BEST OF LUCK