KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

Marks Scored:

Level : B.E.
Year : IV

Course : EPEG 422
Semester: I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

Registration No.:

Date 08 MAR 2019

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose the most appropriate answer.

1. The …….. speed control method is preferred for constant torque drive in a dc machine drive
   a. field flux
   b. armature voltage
   c. mechanical load
   d. starting resistance

2. The ……. braking is not possible in series motor
   a. regenerative
   b. counter current
   c. dynamic
   d. rheostat

3. A four quadrant operation requires
   a. two full converters connected in series.
   b. two full converters connected in parallel.
   c. two full converters connected in parallel with reactor in between the two converters.
   d. two semi converters connected in parallel with reactor in between the two converters.

4. The following motor is preferred for automatic drives
   a. Squirrel cage induction motor.
   b. Synchronous motor.
   c. Ward Leonard controlled dc motors.
   d. Slip ring induction motors.

5. The selection of an electric motor for a floor mill require following characteristic to be of less significance
   a. running characteristic.
   b. starting characteristic.
   c. efficiency.
   d. braking.

6. The armature voltage of a dc motor can be controlled by inserting
   a. Cycloconverters in the armature winding.
   b. Phase controlled rectifier in the field winding.
   c. Phase controlled rectifier in the armature winding.
   d. Diode rectifier in the armature winding.

7. The speed of a dc motor can be decreased by
   a. increasing the thyristor firing angle in the armature circuit of a phase controlled converter.
   b. decreasing the thyristor firing angle in the armature circuit of phase controlled converter.
   c. increasing the duty cycle of a chopper.
   d. decreasing the duty cycle of a chopper.

8. A freewheeling diode in an uncontrolled rectifier
   a. increases the chances of discontinuous conduction in the load.
   b. decreases the chance of discontinuous conduction in the load.
   c. causes the chance of discontinuous conduction in the load.
   d. has no effect in the circuit.

9. The volt-hertz method of speed control of an induction motor using pulse width modulated inverter result in
   a. constant torque operation.
   b. speed reversal.
   c. reduced magnetic loss.
   d. harmonics elimination.

10. Static Scherbius drive method of operation of speed control of an induction motor is used for
   a. sub synchronous speed control only.
   b. super synchronous speed control only.
   c. both sub synchronous and super synchronous speed control.
   d. constant speed operation only.

11. The following method is most commonly implemented in slip power recovery method for the speed control of slip ring induction motor
   a. Rotor resistance control.
   b. Rotor chopper control.
   c. Injection of emf in rotor.
   d. Static Kramer drive.

12. A separately excited dc motor, operating from a single phase half controlled bridge at a speed of 1440 rpm, has an input voltage of 330 sin314t and a back emf of 80V. The SCR are fired symmetrically at firing angle of 30^0 in every half cycle and the armature has a resistance of 4 Ohm. The average armature current is
   a. 58.005 A. b. 29.003 A. c. 221.81 A. d.133.95 A.

13. A 220V, 1000 rpm, 60A separately excited dc motor has an armature resistance of 0.1 Ohm. It is fed from a single phase full converter with an ac source voltage of 230V, 60Hz. The motor speed for firing angle of 150^0 and half rated torque with motor constant of 2.044 Nm/A is
   a. 851.683 rpm. b. - 851.683 rpm. c. - 866.13 rpm. d. 866.13 rpm.

14. For a three phase semi-converter drive the average value of armature current for $\alpha < 60^0$ and $60^0 < \alpha < 180^0$ is respectively
   a. Ia/3 and Ia*(180- α)/360.
   b. Ia and Ia* (180- α)/360.
   c. Ia/3 and Ia* α /360.
   d. Ia*(180- α)/360 and Ia/3.

15. The chopper used for on/off control of a separately excited dc motor has supply voltage of 230Vdc and on time of 10 ms and off time of 15 ms. The average load current for a motor speed of 1500 rpm and voltage constant of 0.5 V/rad per sec for armature resistance of 3 Ohm is
   a. 4.487 A. b. 2.2435 A. c. 101.61 A. d. 29.94 A.

16. A 3 phase, 4 pole 400V, 15 kW, 1440 rpm, 50 Hz, star connected induction motor has rotor leakage impedance of 0.4+j1.6Ω. If this motor is energized from 120 Hz, 400V, 3 phase source, then maximum torque is
   a. 55.262 Nm. b. 99.5 Nm. c. 50 Nm. d. 27.6 Nm.

17. A static Kramer drive is used for the speed control of a 4 pole slip ring induction motor fed from a three phase 415 V, 50 Hz supply. If the motor is require to operate at 1200 rpm, the firing angle of the inverter if voltage across the open circuited slip rings is 700 V is

a. 70.76^0. b. 70.28^0. c. 35.14^0. d. -70.28^0.

18. The most accurate and versatile method of achieving reactive power compensation in a power system is by using

a. thyristor controlled reactors only.
b. thyristor switched capacitors only.
c. parallel combination of both thyristor-controlled reactors and thyristor switched capacitors
d. synchronous condesators only.

19. A three phase 400V, 4 pole star connected reluctance motor has direct axis reactance of 8 Ohm and quadrature axis reactance of 2 Ohm. For a load torque of 80 Nm, the load angle is

a. 27.764^0. b. 4.011^0. c. 8.022^0. d. 12.832^0.

20. An alternator is connected to an infinite bus-bar. Its excitation is increased while its driving power remains constant. This will result in

a. Less leading power factor.
b. More leading power factor.
c. Terminal voltage drop.
d. Terminal voltage increase.

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SECTION "B"
[5 Q. × 8 = 40 marks]

Attempt *ANY FIVE* questions. Assume any suitable data if required.

1.

a. A separately excited dc motor is fed through two single semi-converters, one for the armature circuit and other for the field circuit.
   i. Describe the operating principle of a semi-converter fed dc motor drive waveforms with plot of input supply voltage, armature current, source current, current through thyristors and current through freewheeling diodes at the armature circuit. [2.5]
   ii. Obtain the expression for the input power factor = $(1+\cos\alpha) * [2/\{\pi(\pi-\alpha)\}]^{1/2}$, where "$\alpha$" is the firing angle of the thyristors. [2.5]

b. A separately excited dc motor is supplied from a dc source of 600V to control the speed of a mechanical load and the field current is maintained constant. The armature resistance and losses are negligible.
   i. If the load torque is T_L = 550 N.m at 1500 rpm, determine the armature current, I_a. [1.5]
   ii. If the armature current remains same as that obtained in (i) and the field current is reduced such that motor runs at speed of 2800 r.p.m, determine the load torque. [1.5]

2.

a. The speed of a 20 hp, 300V, 1800 rpm separately excited dc motor is controlled by a three phase full converter drive. The field current is also controlled by a three phase full converter and set to the maximum possible value. The ac input is three phase star connected 208V, 60 Hz, the armature resistance is Ra = 0.35Ω, the field resistance is R_f =250 Ω, and the motor voltage constant is Kv = 1.15 V/A rad/s. The armature and field current are continuous and ripple free. The viscous friction and no load losses are negligible. Determine,
   i. Delay angle of the armature converter, if the motor supplies rated power at rated speed. [2]
   ii. The no load speed if the delay angle are the same as obtained in (i) and the armature current at no load is 10% of the rated value. [2]

b. A dc motor is powered by a step down dc to dc converter at armature circuit from a 600V dc source. The armature resistance is Ra = 0.03Ω and the field resistance is R_f = 0.05Ω. the back emf constant of the motor is Kv= 15.27 mV/A rad/s. the average armature current is Ia = 450 A. if the duty cycle of the converter is 75%, determine
   i. The input power from the source. [1]
   ii. Equivalent input resistance of the dc to dc converter drive. [1]
   iii. The motor speed. [1]
   iv. The developed torque of the motor. [1]

3.

a. Explain the regenerative braking control mode of a separately excited dc motor through chopper and derive the expression for the minimum and maximum braking speed. [3]

b. A three phase 11.2 kW, 1750 rpm, 460V, 60 Hz, four pole, star connected induction motor has the following parameters: stator resistance = 0.66 Ohm, rotor resistance referred to stator = 0.38 Ohm, stator reactance = 1.14 Ohm, rotor reactance referred to stator = 1.71 Ohm and magnetizing reactance = 33.2 Ohm. The motor is controlled by varying both the voltage and frequency. The volt/hertz ratio, which corresponds to the rated voltage and rated frequency, is maintained constant. Calculate maximum torque and the corresponding speed for,

i. 60 Hz and 30 Hz for given stator resistance of 0.66 Ohm. [2.5]

ii. 60 Hz and 30 Hz for negligible stator resistance and explain the difference in the torque obtained with and without stator resistance. [2.5]

4.

a. Explain stator current method of speed control of induction motor through semiconductor drives showing graph of torque vs speed for different values of stator current. [3]

b. A 3 phase 56 kW, 3560 rpm, 460V, 60 Hz, two pole, star connected induction motor has following parameter; Stator resistance = 0 Ohm, rotor resistance = 0.18 Ohm, stator reactance = 0.13 Ohm, rotor reactance = 0.2 Ohm and magnetizing reactance = 11.4 Ohm. The motor is controlled by varying the supply frequency. If the breakdown torque requirement is 160 N.m, calculate,

i. The supply frequency. [1]

ii. The speed at maximum torque. [1]

c. A static Kramer drive is used for the speed control of a four pole slip ring induction motor fed from a three phase, 415 V, 50 Hz supply system. The inverter is connected directly to the supply. If the motor is required to operate at 1200 rpm, find the firing angle of the inverter. Voltage across the open circuited rotor slip rings at standstill is 700V. The voltage drop across each of the diodes is 0.7 V and thyristors is 1.5 V. the drop across inductor is neglected. [3]

5.

a. Explain dc link static Scherbius drive method of slip power recovery scheme for speed control of slip ring induction motor. [3]

b. An inverter feeds a 20 kW, 4 pole, 50 Hz delta connected three phase induction motor with parameters: stator resistance = 0.6 Ohm, rotor resistance = 0.4 Ohm, stator reactance = rotor reactance = 1.6 Ohm.

i. Calculate the source current and torque at a full load slip of 0.04 when inverter output is 400V, 50 Hz. [2]

ii. Determine the new value of source current and torque, if the inverter output is suddenly reduced to 360 V, 40 Hz. [2]

iii. Explain the difference in the value of torque obtained from (i) and (ii). [1]

6.

a. Explain rotor chopper method of speed control of an induction motor drive. [2]

b. The characteristic of adjustable frequency industrial motor drive shows that for constant power region of torque speed curve the motor torque is inversely proportional to supply frequency and is also called field weakening mode of an induction motor. Derive the expression, $T_e \alpha (1/\omega)$. [4]

c. Explain closed loop control of a dc motor drive. [2]