Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination
March/April,2017

APR 0 7 2017

Level : B.E.
Year : IV
Course : EPEG 422
Semester: I

Exam Roll No. :
Time: 30 mins.
F.M. : 10

Registration No. :
Date :

SECTION "A"
[20 Q × 0.5=10 marks]

Choose the most appropriate answer.

1. The basic elements of a electric drive are
   a. electric motor
   b. control System
   c. electric motor and control system
   d. electrical source and load.

2. An elevator drive is required to operate in
   a. one quadrant only
   b. two quadrants
   c. three quadrants
   d. four quadrants

3. In a dc motor speed above base speed are obtained by
   a. Armature voltage control
   b. Armature current control
   c. Field flux control
   d. Field voltage control

4. A 15 hp, 220V, 2000 rpm separately excited dc motor controls a load requiring a torque of T_L = 45 Nm at a speed of 1200 rpm. The field circuit resistance is R_f = 147Ω, the armature circuit resistance is R_a = 0.25Ω, and the voltage constant of the motor is K_V = 0.7032 V/A rad/s. the field voltage is V_f = 220V. the back e.m.f is
   a. 132.28 V
   b. 220 V
   c. -132.28 V
   d. 100 V

5. For a three phase half wave converter drive, the average output voltage at armature terminal is given as
   a. $\frac{3V_{ml}}{2\pi}(1+\cos\alpha)$
   b. $\frac{3V_{ml}}{\pi}(1+\cos\alpha)$
   c. $\frac{V_{ml}}{3\pi}(\cos\alpha)$
   d. $\frac{3V_{ml}}{2\pi}(\cos\alpha)$

6. For a three phase DC drives, which of the following offers four quadrant operation?
   a. Half wave converter drives
   b. Semi converter drives
   c. Full converter drives
   d. Dual converter drives

7. The firing sequence for a three phase full converter with firing angle $\alpha = 60^0$ is
   a. $60^0, 120^0, 180^0, 240^0, 300^0, 360^0$
   b. $120^0, 180^0, 240^0, 300^0, 360^0, 420^0$
   c. $150^0, 210^0, 270^0, 330^0, 390^0, 450^0$
   d. $210^0, 270^0, 330^0, 390^0, 450^0, 510^0$

8. A step down chopper is operated in the continuous conduction mode in steady state with a constant duty ratio, D. if V_o is the magnitude of the dc output voltage and V_s is the magnitude of dc input voltage, the ratio V_o/V_s is given by
   a. D
   b. 1-D
   c. 1/1-D
   d. D/1-D

9. In type C chopper
   a. the load voltage is always negative but the load current may be positive or negative
   b. the load voltage and the load current are both positive
   c. the load voltage is always positive but load current can be positive or negative
   d. the load voltage and load current are both negative

10. Which of the following system is preferred for chopper drives?
   a. Constant frequency system
   b. Variable frequency system
   c. Constant voltage system
   d. Variable voltage system

11. In an a.c. motor control, the ratio of voltage to frequency is maintained at constant value to
   a. make maximum use of magnetic circuit
   b. make minimum use of magnetic circuit
   c. maximize the current from the supply to provide torque
   d. minimize the current drawn from the supply to provide torque

12. A three phase induction motor develops a torque as a function of slip when supplied from a fixed voltage at constant frequency and operates in motoring region of operation for the following value of slip

   a. $0 \leq s \leq 1$
   b. $s < 0$
   c. $1 \leq s \leq 2$
   d. $s > 2$

13. 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

14. The induction motor is said to be operated in field weakening mode on _____ control method ofa.c. drive
   a. stator voltage
   b. stator frequency
   c. stator voltage and frequency
   d. stator current

15. The slip power recovery scheme for the speed control of induction motor
   a. increase the efficiency
   b. decrease the efficiency
   c. improves the power factor
   d. decreases the power factor

16. The static Kramer drive offers speed control
   a. above synchronous speed
   b. both above and below synchronous speed
   c. below synchronous speed
   d. only at synchronous speed

17. For a cylindrical rotor synchronous motor, the pull-out torque is obtained when the load angle is at
    a. 45^0
    b. 90^0
    c. 180^0
    d. 270^0

18. The developed torque from the salient pole motor is
    a. $(E_f V_t / X_d)*\sin\delta$
    b. $(E_f V_t / X_d)*\sin\delta + (V_t^2 /2) *[1/X_q - 1/X_d]*\sin 2\delta$
    c. $(V_t^2 /2) *[1/X_q - 1/X_d]*\sin 2\delta$
    d. $(E_f V_t / X_d)*\sin\delta + (V_t^2 /2) *[1/X_q - 1/X_d]*\sin\delta$

19. Reluctance motor is equivalent to a
    a. salient pole motor with no armature current
    b. salient pole motor with no field current
    c. cylindrical motor with no field current
    d. cylindrical motor with no armature current

20. An additional synchronous motor is added having an input power of 90 kW and a maximum power factor of 0.85 leading to a load of 450 kVA operating at p.f of 0.65 lagging The new power factor obtained is
    a. 0.8 leading
    b. 0.6 leading
    c. 0.8 lagging
    d. 0.6 lagging

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SECTION "B"
[5 Q × 8 = 40 marks]

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

1.

a. Define an electric drive system with a suitable diagram. [4]

b. A 230 V, 1000 r.p.m, 60 A separately excited dc motor has an armature resistance of 0.1Ω. It is fed from a single phase full converter with an a.c. source voltage of 230V, 50 Hz. Assuming continuous conduction mode, determine:
   i. Firing angle for rated motor torque at 600 r.p.m.
   ii. Motor speed for $\alpha=150^0$ and half rated torque. [2+2=4]

2.

a. Describe how the speed of a dc series motor can be controlled by means of a dc chopper. Derive necessary expression. [4]

b. A dc series, fed from 400 V dc source through a chopper, has the following parameters: $r_a = 0.05\ \Omega$, $r_s = 0.07\ \Omega$, $k = 5 \times 10^{-3}$ Nm/A^2
   The average armature current of 200 A is ripple free. For a chopper duty cycle of 50%, determine:
   i. Input power from the source.
   ii. Motor speed and torque. [2+2=4]

3.

a. A three-phase 400V, 50Hz, 4 pole star connected induction motor has the following parameters R_s= 1.01 Ω, R_r=0.69 Ω, X_s=1.3 Ω, X_r=1.94 Ω, and X_m=43.5 Ω. The no load loss, P_{noload}, is negligible. The load torque, which is proportional to the speed squared, is 50 N.m at 1800 rpm. If the motor speed is 1500 rpm, determine
   i. Load torque, T_L.
   ii. Rotor current I_r.
   iii. Stator supply voltage, V_s.
   iv. Slip for maximum current, s_a. [1+1+1+1=4]

b. Explain why in stator frequency control of induction motor drive, the motor is said to be operated in field weakening mode. Derive the necessary expression for obtaining the torque-speed curve. [4]

4.

a. A 3 phase, 400V, 4 pole, 50 Hz star connected SRIM has the following per phase parameters referred to stator:

$$R_s = 0.1\Omega,\ R_r = 0.08\Omega,\ X_s = X_r = 0.3\Omega,\ X_m = 0$$

Per phase turns ratio from rotor to stator is 0.7. The speed of this motor is controlled by a GTO in its rotor circuit. For a speed of 800 rpm, the inductor current is 110A and the chopper resistance is 2Ω. Calculate

i. Value of chopper duty cycle.

ii. Efficiency for a power output of 25kW and for negligible no load losses. [2+2=4]

b. Describe static Kramer drive for the speed control of a 3-phase SRIM and show that the steady state torque is not influenced by whether a transformer is used or not. [4]

5.

a. Derive an expressions for power developed for cylindrical rotor synchronous motor in terms of excitation voltage, load angle. Plot the variation of pull out torque and pull out power with frequency for a cylindrical rotor motor. [3+1=4]

b. Describe self-controlled synchronous motor drive with load commuted inverter.

A three phase, 230 V, 60 Hz, 4 pole, star connected reluctance motor with negligible armature resistance, has $X_d = 22.5\Omega$ and $X_q = 3.5\Omega$. For a load torque of 12.5 Nm, the voltage to frequency ratio is maintained constant at rated value, determine

i. Load angle (δ).

ii. Line current (I_a).

iii. Input power factor (θ). [1+3=4]

6.

a. List out the different types of power factor correction employed. Mention the benefits of power factor correction. Explain any one type of power factor correction method. [1+1+2=4]

b. Plot the output voltage, V_o wave form for a three phase full converter dc motor drive considering firing angle, $\alpha = 60^0$. [4]