FACULTY OF ENGINEERING

END OF SEMESTER EXAMINATIONS - APRIL 2025

PROGRAMME: BACHELOR OF ELECTRICAL AND CONTROL ENGINEERING

YEAR/SEM: YEAR 4/SEMESTER 2

COURSE CODE: ELE4221

NAME: ELECTRICAL DRIVES II

DATE: 2025-04-17

TIME: 9:00AM-12:00PM

INSTRUCTIONS TO CANDIDATES:

1. Read the instructions very carefully

2. The time allowed for this examination is STRICTLY three hours

3. Read each question carefully before you attempt and allocate your time equally between all the Sections

4. Write clearly and legibly. Illegible handwriting cannot be marked

5. Number the questions you have attempted

6. Use of appropriate workplace examples to illustrate your answers will earn you bonus marks

7. Any examination malpractice detected will lead to automatic disqualification.

DO NOT WRITE ANYTHING ON THE QUESTION PAPER

Section A Choose any two questions from this section. All questions carry equal marks (20MKS)

Question 1:

Choose the correct answer. @ 2mks

Q1. DC motor is recommended for the Locomotive drive is:
A. DC series Motor
B. DC long shunt compound Motor
C. DC Shunt Motor
D. DC short shunt compound Motor

Q2. In case of a 3 phase induction motor, plugging is done by:
A. Starting the motor on load which is more than the rated load
B. Pulling the motor directly on line without a starter
C. Interchanging connections of any two phases of the stator for quick stopping
D. Locking of the rotor due to harmonics

Q3. In the method of speed control of an induction motor by inducing EMF in the rotor circuit, if the injected voltage is in the phase opposition to the induced rotor EMF, then
A. The rotor resistance Increase
B. The rotor reactance increase
C. The rotor reactance decrease
D. The rotor resistance decrease

Q4. Which of the following motors can be used as the part of the control circuit in the robotic application?
A. AC series Motor
B. Universal Motor

C. Servo Motor

D. Scharge Motor

Q5.An air core transformer as compared to iron-core transformer has
   A. Less magnetic core loss
   B. More magnetic core loss
   C. No magnetic core loss
   D. Less ohmic loss.

Q6. In the direct-online starter, NO-VOLT release is to

A. Safeguard the motor against the failure of the supply

B. Safeguard against earth fault

C. Safeguard against Overload

D. Safeguard against supply fluctuation

Q7 To save energy during braking-----------------braking is used?

A. dynamic

B. plugging

C. regenerative

D. all of the above

Q8. Which of the following are electrical braking methods?

A. plugging

B. dynamic

C. regenerative

D. all of the above

Q9â?¤ Polarity of supply voltage is reversed in which type of braking?
   A. Regenerative braking.
   B. Dynamic braking.
   C. Plugging.
   D. None of these.

Q10. The basic elements of a electric drive are

A. electric motor.

B. control system.

C. electrical motor and control system.

D. none of the above.

Question 2:

Choose the correct answer. @ 2mks

Q1. A coupling magnetic field inside a rotating machine or static machine like transformers must involve with _____

I. electrical system to extract energy from electrical system.

II. mechanical system to extract energy from electrical system.

A. Only I is true

B. Only II is true

C. I and II are true
D. I and II are false

Q2. Stepping of the core is implemented in the core to _____
A. reduce conductor material and copper losses
B. reduce core loss
C. to provide mechanical strength
D. to reduce magnetizing current

Q3. A synchronous Motor is found more economical when the load is above
A. 1 kW
B. 10 kW
C. 20 kW
D. 100 kW

Q4. When quick speed reversal is a consideration, the motor preferred is
A. Synchronous Motor
B. Squirrel cage Induction Motor
C. Wound Rotor induction motor
D. DC motor

Q5. The selection of control gear for a particular application is based on the consideration of
A. Duty
B. Starting Torque
C. Limitation of starting current

D. All of the above

Q6. Core type transformers have, LV and HV windings are arranged such that _____
A. Half LV near the core and half HV outside LV on each limb
B.LV one one limb and HV on the other
C. Half LV outside the core and half HV inside LV on each limb
D. LV and HV windings are sandwiched

Q7. The consideration involved in the selection of the type of electric drive for a particular application depends upon;

    A. Speed control range and its nature
    B. Starting Nature
    C. Environmental condition
    D. All of the above

Q8. The shell type transformers have, LV and HV windings are arranged such that _____

    A. Half LV near the core and half HV outside LV on each limb
    B. LV one one limb and HV on the other
    C. Half LV outside the core and half HV inside LV on each limb
    D. LV and HV windings are sandwiched

Q9. The flashpoint of transformer oil should be higher then

  A. 40^0C
  B. 60^0C
  C. 80^0C
  D. 104^0C

Q10. How are the ratings of machines, losses and temperature rise related?

    A. increase, decrease, increase
    B. decrease, increase, increase
    C. increase, increase, increase
    D. decrease, increase, decrease

Question 3:

Choose the correct answer. @ 2mks

Q1. Helical windings are used in

  A. Distribution transformers
  B. Power transformers

C. Shell type transformers
D. None of the above

Q2. In Transformers using hotrolled steel, the cross-section of the yoke is made about...... greater than that of the core

   A. 5%
   B. 10%
   C. 15%
   D. None of the above

Q3. Yokes with a rectangular cross-section are used of

   A. Small capacity transformers
   B. Medium capacity transformers
   C. Large capacity transformers
   D. Any of the above

Q4. Oil for transformer cooling should have low
   A. dielectric strength
   B. viscosity
   C. flash point.

Q5. The torque Motor design is very similar to that of
A. Induction Motor
B. DC Motor
C. Single Phase Motor
D. Rotary Synchronous Motor

Q6. Switchable Speed drive, Open Loop speed drive, closed loop speed drives are the example of
A. Fixed speed Drive
B. Variable Speed drive
C. Servo Drive
D. Any of the above

Q7. Which switch is used for the automatic control of the motor**?**

    A. Hand OFF auto switch

    B. Hand ON auto Switch

    C. Rheostatic switch

    D. Any of the above

Q8. The oil selected for transformer cooling should be free from

    A. alkalies

    B. acids

    C. sulphur

    D. all of the above.

Q9.Normally for the design of transformer the ambient temperature is taken as

    A. 20°C

    B. 25°C

    C. 45°C

    D. 75°C.

Q10. Three-point starter can be used for

A. Both shunt and compound Motors

B. Shunt Motor Only

C. Series Motor Only

D. Compound Motor Only

Question 4:

Choose the correct answer. @ 2mks

Q1. How are the losses in the transformer and rotating machines converted to?

    A. the losses are converted to electrical energy

    B. the losses are converted to electrical and mechanical energy

    C. the losses are converted to mechanical energy

    D .the losses are converted to thermal energy

Q2. In 4 quadrant operation of a hoist 3rd quadrant represents

    A. reverse motoring.

    B. reverse braking.

    C. forward braking.

    D. forward motoring.

Q3₥ Which of the following factor mainly determines the type of insulation for an electrical machine?

A A. Maximum allowable flux density
B B. Maximum operating temperature
C C. Maximum efficiency of the machine
   D. Maximum allowable loss in machine

Q4. Which of the following is not a major component of an electric drive system.
   A. Motor
   B. Power converter
   C. Controller
   D. None of the above

Q5. Which of the following is a major consideration to evolve a good design of an electrical machine?
   A. Specific electric loading
   B. Specific magnetic loading.
   C. Temperature rise.
   D. All of the above

Q6. Which type of motor is generally preferred for applications requiring high starting torque?
   A. Synchronous motor
   B. Induction motor
   C. DC shunt motor
   D. Reluctance motor

Q7. The best choice of motor for applications with variable load conditions is:
   A. Squirrel cage induction motor
   B. Stepper motor
   C. DC series motor
   D. Universal motor

Q8. Which motor is most suitable for constant speed applications?
   A. DC series motor
   B. DC shunt motor
   C. Synchronous motor
   D. Universal motor

Q9. For applications requiring frequent starting and stopping, the preferred motor is:
   A. Induction motor
   B. DC shunt motor
   C. Brushless DC motor
   D. Stepper motor

Q10. Which factor is crucial in selecting a motor for high inertia loads?
   A. Torque-speed characteristics
   B. Efficiency
   C. Power factor
   D. Cooling method

Section B Choose any three questions from this section. All questions carry equal marks(20MKS) each.

Question 1:

a. Briefly describe **the construction** of a three phase induction motor?
b. Describe briefly **some methods of starting** 3-Phase induction motors?
c. Discuss the **different loadings** used in induction motor design and hence give their mathematical expressions?
d. Develop the **output motor power equation** for a three phase induction motor used in the design methodology and hence deduce the **output coefficient Co**.
e. A 3 phase **450 kVA, 3.3 kV, 50 Hz, 300 rpm,** salient pole alternator has the following design   data.

> Stator bore diameter = 230 cm
> Gross length of stator bore = 35 cm
> Number of stator slots = 216
> Number of conductors per slot = 4
> Sectional area of stator conductor = 86 mm^2

Using the above data, **calculate**
  i.   Flux per pole
  ii.   Flux density in the air gap
  iii.   Current density
  iv.   Size of stator slot

Question 2:

a. a. By citing some **practical applications** explain what is meant by a transformer.
b. b. In transformer design, the **out-put equation** serves as the reference for the design;

  i.   **Prove** that the **out-put expression** for a single phase type of transformer is given by;

$$Q = 2.22 \, f \, A_i \, B_m \, \delta \, K_w \, A_w \times 10^{-3} \quad KVA$$

And hence state what each parameter represents and the S.I units of measurement.
  ii.   From the expression, deduce the **out-put expressions** for following types of transformers.
  Ã? 3-phase core type transformer
  Ã? 3- phase shell type transformer

c. c. Design parameters in a transformer are split into **seven types**, briefly discuss.
d. d. Briefly discuss the following **parameters** as applied to transformer design.
  i.   Transformer Tank Design:
  ii.   Estimation of no. of turn on the LV and HV windings

  iii. Estimation of the sectional area of the primary and secondary windings.

Question 3:

a. Define what a **D-Q model** of a machine is and hence state its significance in electrical Engineering
b. Write short notes on some of **the applications** of the **D-Q model** of the machine

c. Draw the **equivalent circuit of a DC machine** and hence derive the **equation for the electro-magnetic torque** defining each of the parameters with their SI units.
d. From the equation above,
  i. Derive the **state-space model** of DC machine
  ii. The **final transfer function** of the model using the block reduction technique
e. What are some of the **limitations** of this model?
f. Explain briefly, Voltage and Speed control of DC machines based on D-Q model.

Question 4:

a. Explain the **key factors that determine the selection** of an electrical motor or generator for domestic or industrial applications.
b. Describe the **different types of loads** and explain how these affect the selection of motors and generators.
c. Discuss **various load profiles** and how they influence the choice of electrical machines. Provide examples of applications where specific types of motors or generators are best suited.
d. Explain the **concept of load matching and its importance** in optimizing efficiency, performance, and reliability of electrical machines in industrial and commercial applications.