Exam Drive Systems Oral

Neighbours

Lecturer: Daniel T. McGuiness, Ph.D

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SEMESTER: SS 2024
DATE:
TIME: 09:00 - 10:30

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First and Last Name

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Student Registration Number

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Grading Scheme	$\geq 90\%$	1
	$\leq 80\%$ and $\geq 90\%$	2
	$\leq 70\%$ and $\geq 80\%$	3
	$\leq 60\%$ and $\geq 70\%$	4
	$\leq 60\%$	5

Result:

___/ max. 100 points

Grade:

Student Cohort

Study Programme M.Sc Smart Technologies

Permitted Tools Nothing is allowed.

Important Notes

Unnecessary Items

Place all items not relevant to the test (including mobile phones, smartwatches, etc.) out of your reach.

Identification (ID)

Lay your student ID or an official ID visibly on the table in front of you.

Examination Sheets

Use only the provided examination sheets and label each sheet with your name and your student registration number. The sheets be labelled on the front. Do not tear up the examination sheets.

Writing materials

Do not use a pencil or red pen and write legibly.

Good Luck!

Question	Maximum Point	Result
Oral Exam Questions	100	
Sum	100	

[Q1] Oral Exam Questions — 100

Questions will be asked based on the points add up to 100.

1. Draw a 3-phase current waveform (R, B, Y), show the phase difference between each phases and write the mathematical equations for three currents. ljm (20)
2. Draw the circuit diagram for the star (Y) and delta (Δ) connections and write down their current and voltage relations. (30)
3. In a delta (Δ) connection, the line and the phase current are equal. (5)
4. In a star (Y) connection, the line and the phase current are equal. (5)
5. Why is 3-phase used in industry compared to other multi-phase systems? (10)
6. In a 6-phase electric drive, phases are separated physically (m) by 180 degrees. (5)
7. What is the minimum number of phases needed to create a functioning Rotating Magnetic Field? (10)
8. Between star (Y) and delta (Δ) which one has no neutral connection? (10)
9. Describe the relation between the real, reactive, and apparent power using a triangle and write all the relevant units and symbols associated with it. (30)
10. In terms of active and reactive power, what would be of an induction generator? would it generate reactive power and generate active power for example. (5)
11. What are the two (2) main components of an electrical drive? (10)
12. How would you change the rotation of a 3-phase rotating magnetic field ? (10)
13. How would you change the rotation of a 5-phase rotating magnetic field ? (10)
14. How would you change the rotation of a 7-phase rotating magnetic field ? (10)
15. What is the relation between the net magnetic field (Bnet) and the number of phases (n)? (10)
16. What happens when a motor is constructed with more poles (i.e., 2p=2 to 2p=4)? What operational, physical differences would be observable between them? (10)
17. What is the maximum speed achievable using the European grid with a pole value of 2p=2 in terms of rpm? (10)

18. What is the maximum speed achievable using the North American grid with a pole value of 2p=2 in terms of rpm? (10)
19. What the technical definition of phase angle (). (10)
20. Please draw a 3-phase RMF using R, B, Y phases with R leading B leading Y. Once drawn please show the rotation (CW, CCW) of the field on the diagram. (20)
21. To create a 5-phase RMF how should the phases be separated electrically (e) and physically (m) in terms of angles. (10)
22. Write down the equation for a 3-phase RMF rotating clockwise. (5)
23. Write down the equation for a 3-phase RMF rotating counter-clockwise. (5)
24. What is/are the fundamental physical principle(s) behind the torque generation of an induction/asynchronous drive? (5)
25. Why is an induction drive called by that name? (5)
26. What is/are the reason(s) an induction drive is preferred in industry? (10)
27. Low power induction drives (<5 kW) are considered self-starting. (5)
28. What is/are the advantage(s)/disadvantage(s) of an induction drive? (10)
29. Induction drives are easier to have variable speed control compared to a permanent magnet synchronous motor. (5)
30. Please draw a section (i.e., cut) diagram of an induction drive and explain each major component along with preferred materials used in industry. (30)
31. What is the purpose of lamination in an induction drive? (5)
32. Why is electrical steel preferred during the construction of induction drives? (5)
33. What are the major types of induction motor rotor types? Briefly explain them and compare the following criteria: (20)
    - Construction,
    - Rotor resistance,
    - Starting torque,
    - Maintenance,
    - Build cost,
    - and industrial Use.
34. Write down the relation between the stator RMF speed (n), stator frequency (f) and the number of poles (p) for an induction drive. (5)
35. Briefly explain Faraday's law of induction in one sentence. (5)

36. Briefly explain Ampere's law in one sentence. (5)

37. What causes the rotation on a squirrel cage induction rotor? (10)

38. What is the technical term for inclination of the rotor rods relative to the axis of rotation in a squirrel cage rotor? (5)

39. Why is skewing done on the rotor rods of a squirrel cage? (5)

40. What happens to the short circuited rods of a squirrel care rotor when they are perfectly aligned with the axis of rotation? (5)

41. What is the definition of slip, how is it calculated, and please write down the equation and explain the variables. (10)

42. An induction drive can operate in motor mode with a negative slip. (5)

43. What is the possible range of a slip value in motor operation? (5)

44. What behaviour is expected when the slip of an induction drive is 0? (5)

45. What behaviour is expected when the slip of an induction drive is 1? (5)

46. An induction drive can generate torque while having a slip value of 0. (5)

47. What are the rated slip values for a low to medium induction drive in normal operation? (5)

48. What are the slip values for idling mode and short circuit mode in an induction drive respectively? (5)

49. Slip of an induction drive depends on the mechanical load on the shaft. (5)

50. The slip of rated load is called the rated (nominal) slip. (5)

51. What is cogging in electric drives and why does it happens ? (10)

52. An induction drive is analogous to a transformer with a rotating primary. (5)

53. Please draw the equivalent circuit for an induction drive and explain each component with secondary referred. (30)

54. The magnetising inductance of an induction drive needs to be referred to the primary side in the equivalent circuit model. (5)

55. Please draw the torque speed plot of an induction drive covering breaking, motor and generator region and explain the important points. (30)

56. At the time of starting, the initial current of an induction drive is above the rated current. (5)

57. Inrush current lasts over seconds. (5)

58. What is the purpose of a starter in induction drives? (5)
59. In an induction drive, torque is proportional to the cube of the applied voltage. (5)
60. What is inrush current and what is done to mitigate it? (10)
61. Explain the Direct on-line starter method. (10)
62. Direct on-line starter method does not provide control over the inrush current. (5)
63. Explain the Auto-transformer starter method. (10)
64. Auto-transformer starting method is only usable in star (Y) connection. (5)
65. Auto-transformer starting method is only usable in delta (Δ) connection. (5)
66. Auto-transformer starting method is usable in both star (Y) and delta (Δ) connection. (5)
67. In an Auto-transformer starting method, the auto-transformer stays connected after the motor reaches rated speed. (5)
68. In an Auto-transformer starting method, the auto-transformer doesn't stay connected after the motor reaches rated speed. (5)
69. Explain the Star/Delta starter method. (10)
70. In a (Y/Δ) the motor starts in delta connection and operates under star connection. (5)
71. In a S/D the motor starts in star connection and operates under delta connection. (5)
72. Explain the slip-Ring Induction motor starter method. (10)
73. Slip-Ring starter can only be used in wound rotor induction motor. (5)
74. Slip-Ring starter can only be used in wound squirrel-cage induction motor. (5)
75. Slip-Ring starter can only be used in both rotor-types. (5)
76. In a squirrel cage rotor would you expect to have voltage potential difference on the rotor rods? (5)
77. LIMs have a finite primary or secondary length. (5)
78. When are LIM are desirable? (10)
79. LIMs can be used in poly-phase supply. (5)
80. LIMs are less efficient than normal rotary motors for any given required force output. (5)
81. LIMs a normal rotary motors for any given required force output. (5)
82. What are the practical uses and applications of a Linear Induction Motor? (10)
83. Why is ferromagnetic core is chosen for use in Rotor in LIM construction? (5)

84. Please draw a diagram showing how one converts a rotary motor into linear. (20)
85. Please write the speed equation of a LIM. (10)
86. What is the difference between a LIM and a double sided LIM. (5)
87. Thrust in a LIM is analogous to torque of an IM. (5)
88. What is the goodness factor, write the equation and describe the variables. (20)
89. What is magnetic levitation. (10)
90. What are the two primary issues involved in magnetic levitation? (10)
91. Essentially all types of magnets can be used to generate lift for magnetic levitation. (5)
92. A Three-phase induction motor can run and start from a single-phase supply. (5)
93. How can a three-phase IM start with a single phase supply? (10)
94. Using drawing please explain the single-phase rotating magnetic field and show why is it not possible to create motion. (30)
95. Construction wise, 1-phase rotor is similar to 3-phase. (5)
96. How can a single-phase motor achieve rotation? (10)
97. Please list the types of single-phase induction motors mentioned in the lecture in name only. (20)
98. Please explain the permanent-split induction motor and elaborate on its advantages and disadvantages. (20)
99. Please explain the capacitor-start induction motor. (20)
100. Please explain the capacitor-run induction motor. (20)
101. Please explain the resistance-split phase induction motor. (20)
102. Please explain the construction of a shaded-pole induction motor. (20)
103. Please explain the four assumptions made to derive the dynamic model of an IM. (15)
104. What does uniform air gap mean for electric drive construction, and please explain your answer with a drawing. (10)
105. What does MMF stand for and please explain briefly the meaning behind sinusoidal distributed MMF. (10)
106. The assumption of uniform air gap makes self-inductances independent of angular positions. (5)
107. dq0 transformation is reversible. (5)

108. transformation is not reversible. (5)

109. If an unbalanced 3-phase input is given to transform what would you expect the outcome to be? (10)

110. Please explain Clarke transform and why is it used? (20)

111. Please explaine Park transform and why is it used? (20)

112. What are the four (4) types of reference frames used in dynamic modelling of an induction drive? (10)

113. Explain stator reference model and which situation is it desirable. (10)

114. Explain rotor reference model and which situation is it desirable. (10)

115. Explain synchronous reference model and which situation is it desirable. (10)

116. Please write down the power relationship between a two phase and a three phase motor. (10)

117. What is the per unit modelling, briefly explain the concept behind it. (10)

118. Please write down the The electromechanical dynamic equation and explain the parameters. (10)

119. What are the SI units of: (20)
    - voltage,
    - resistance,
    - inductance,
    - impedance,
    - torque,
    - inertia,
    - frequency,
    - angular speed,
    - number of poles,
    - and friction constant.

120. The IM synchronous (i.e., stator RMF) speed can be changed by which methods ? (10)

121. The slip (s) can be changed by which method(s) ? (10)

122. Please explain the pole changing method (10)

123. Briefly explain thevenin circuit theorem. (10)

124. How is V/f control achieved and how does the torque curve behave under different supply frequencies. (20)

125. Decreasing f in V/f control increases rated slip. (5)

126. Explain how rotor-resistance control work and show its behaviour on a torque-speed plot. (20)

127. What are the principal disadvantages of line-voltage and rotor-resistance control methods? (10)

128. What is field operated control and how does it work conceptually? (20)

129. Why is dq0 transform used? (10)

130. The initial guess of the rotor position of an induction drive plays a significant role on the overall performance. (10)

131. Why are PMs preferred over electromagnets? (10)

132. Please name the three types of magnets used in industry? (10)

133. Explain the in-runner and out-runner motor types. (10)

134. Based on the flux how can you classify electric drives? (10)

135. What are the advantages/disadvantages of axial rotor design? (10)

136. PMSM has a trapezoidal back emf (5)

137. BLDC has a sinusoidal back emf. (10)

138. Why is sensor-less control developed? (10)