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Daffodil International University

Department of Electrical and Electronic Engineering
Faculty of Engineering
Final-Term Examination, Summer – 2026

Course Code: **0713-213** Course Title: Energy Conversion I
Section: A/B/C/D/E/F/G Level-Term: L2-T1 Teacher's Initial: DRA / PA/ RS
Full Marks: 40 Exam Date: August 19, 2026 Time: 2.0 Hours

Attempt to Answer all 4 Questions

Q1. a) **Explain** the production of a rotating magnetic field in a two-phase supply using vector diagram of flux. **[4]**

b) The rotor resistance and reactance per phase of a 4-pole, 50-Hz, 3-phase induction motor are 0.025 Ω and 0.12 Ω, respectively. The full-load slip is 5%. **Find** the additional rotor resistance per phase that must be inserted so that the starting torque is equal to one-half of the full-load torque. **[4]**

Q2. a) **Prove** the condition for maximum full-load torque and hence determine the maximum full-load torque. **CO-2 C(2) [3]**

b) A 746-kW, 3-phase, 50-Hz, 16-pole induction motor has a rotor impedance of (0.02+j0.15)Ω at standstill. The full-load torque is obtained at 360 rpm. **Calculate:** **CO-2 C(4) [6]**

i. The ratio of maximum torque to full-load torque.
ii. The speed at maximum torque.
iii. The rotor resistance to be added to obtain maximum starting torque.

Q3. a) **Show** the condition for maximum efficiency of a transformer and determine the output current at which maximum efficiency occurs. **CO-2 C(2) [3]**

b) A 50-kVA, 2200/220-V, single-phase transformer has a full-load copper loss of 800 W and an iron (core) loss of 500 W. The transformer operates at a power factor of 0.8 lagging. **Calculate:** **CO-2 C(4) [6]**

i. The output current at which maximum efficiency occurs.
ii. The maximum efficiency of the transformer at 0.8 power factor.
iii. The efficiency of the transformer at half-load and 0.8 power factor.

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Q4. Answer any 2 (Two) from the following 4 questions:

a) A 220-V, 3-phase, 4-pole, 50-Hz, Y-connected induction motor is rated 3.73 kW. The equivalent circuit parameters are: $R_1 = 0.5\ \Omega$; $X_1 = 0.9\ \Omega$; $R'_2 = 0.8\ \Omega$; $X'_2 = 1.25\ \Omega$; $X_m = 30\ \Omega$. The stator core loss is 50 W and rotational loss is 150 W. For a slip of 0.04, **find**: (i) Input current, (ii) Power factor, (iii) Air-gap power, (iv) Mechanical power, (v) Output power, and (vi) Efficiency. **CO-3 C(5) [7]**

b) A 3-phase, 400-V, Y-connected induction motor has an equivalent T-circuit consisting of: $R_1 = 1\ \Omega$, $X_1 = 2\ \Omega$. Equivalent rotor values: $R'_2 = 1.2\ \Omega$, $X'_2 = 1.5\ \Omega$. The exciting branch has an impedance of $(4 + j40)\ \Omega$. Assume friction loss to be 250 W. If the slip is 5%, **find**: (i) Input current, (ii) Power factor, (iii) Output power, and (iv) Efficiency **CO-3 C(5) [7]**

c) Two 100-kW transformers each have a maximum efficiency of 98%, but in one transformer the maximum efficiency occurs at full-load, while in the other it occurs at half-load. Each transformer is on full-load for 4 hours, on half-load for 6 hours, and on one-tenth load for 14 hours per day. **Determine** the all-day efficiency of each transformer. **CO-3 C(5) [7]**

d) A 5 kVA, 220/400-V, single-phase transformer has equivalent resistance and reactance referred to LV side equal to 1.0 Ω and 1.5 Ω respectively. Find the terminal voltage on the HV side when it supplies 3/4th full-load at power factor of 0.8, the supply voltage being 220V. Hence, **find** the output of the transformer and its efficiency if the core losses are 130 W. **CO-3 C(5) [7]**