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Daffodil International University

Department of Electrical and Electronic Engineering

Faculty of Engineering

Final Term Examination, Spring 2026

Course Code: **0713-213**
Section: A, B, C, D
Full Marks: **40**

Course Title: **Energy Conversion I**
Level-Term: L2 - T1
Exam Date: April 25, 2026

Teacher's Initial: DRA, PA
Time: 2.0 Hours

Attempt to Answer all of the 4 Questions

The second right most column indicates the course outcomes with respective Bloom's level and right most column indicates the allocated marks

Q1. a) **Explain** in your own words **any two** of the following: [4]
Auto-Transformer, Single-Phase Induction Motor, Induction Generator, Parallel Operation of Transformers.

Q1. b) A 4-pole, 50-Hz, 3-Φ induction motor develops a maximum torque of 60.8 Nm at 1375 rpm. The resistance of the star-connected rotor is 0.15 Ω/phase. **Calculate** the value of the resistance that must be inserted in series with each rotor phase to produce a starting torque equal to 3/4th of the maximum torque. [4]

Q2. a) **Show** that a transformer achieves maximum efficiency when copper losses are equal to iron losses. **CO-2 C(2)** [3]

Q2. b) A 5.6 kVA, 50 Hz, 250/400 V single-phase transformer undergoes open-circuit and short-circuit tests with the following test data: **CO-2 C(4)** [6]
Open-circuit test: Voltage = 250 V, Current = .5 A, Power = 80 W – core on LV side
Short-circuit test: Voltage = 20 V, Current = 20 A, Power = 50 W – HV shorted
Calculate (i) equivalent circuit parameters w. r. to LV side, (ii) efficiency and (iii) the terminal voltage on the HV side when it supplies 1/4th of full load with a 0.8 power factor lagging, the supply voltage being 250 V.

Q3. a) **Prove** that maximum starting torque is achieved when rotor resistance is equal to rotor reactance. **CO-2 C(2)** [3]

Q3. b) 3-phase induction motor having a 6-pole, star-connected stator winding runs on 250-V, 50-Hz supply. The rotor resistance and standstill reactance are 0.12 ohm and 0.85 ohm per phase. The ratio of stator to rotor turns is 1.8. Full load slip is 4%. Calculate the developed torque at full load, maximum torque and speed at maximum torque. **CO-2 C(4)** [6]

P.T.O.

250

$P = VI$

$\Rightarrow I = \frac{P}{V} \times \frac{1}{4}$

$= \frac{50}{400} \times \frac{1}{4}$

$\eta = \frac{P_{out}}{P_{in}}$

$P_{in} = \frac{P_{out}}{\eta}$

Answer any 2 (Two) from the following 3 (Three) questions:

Q4. a) A 230-V, 3-φ, 4-pole, 50-Hz, Y-connected induction motor is rated 3.8 kW. The equivalent circuit parameters are: $R_1 = 0.$ Ω, $X_1 = 0.8$ Ω; $R_2' = 0.45$ Ω, $X_2' = 1.2$ Ω, $X_m = 30$ Ω. The stator core loss is 60 W and rotational loss is 140 W. For a slip of 0.04, **compute:** (i) input current, I_1 (ii) air-gap power, P_2 (iii) mechanical power, P_m (iv) gross torque, T_g (v) output power, P_{out} and (vi) efficiency, η. **CO-3** **C(5)** **[7]**

Q4. b) A 120V, 60-Hz, 3-phase, Y-Connected, 6-pole induction motor has an equivalent T-circuit consisting of stator impedance of (0.07 + j 0.3) Ω and an equivalent rotor impedance at standstill of (0.08 + j 0.3) Ω. Magnetizing branch has $X_m = 6.33$ Ω, $R_0 = 45.45$ Ω. **Determine** (a) rotor current, I_2' (b) stator current, I_1 (c) primary p.f. (d) gross power output, P_g (e) gross torque, T_g f) input power, P_1 and (g) gross efficiency by using approximate equivalent circuit. Assume a slip of 2%. **CO-3** **C(5)** **[7]**

Q4. c) A 10-kVA distribution transformer has a full-load efficiency at unity p.f. of 98%, the copper and iron losses then being equal. **Calculate** its all-day efficiency if it is loaded throughout the 24 hours as follows: One-fourth load for 10 hours; Quarter load for 3 hours; Half load for 6 hours; and Full load for 5 hours. Assume load p.f. of unity. **CO-3** **C(5)** **[7]**