B.Sc. Engg. EE, 3rd Sem.
DTE, 1st Sem.

Date: October 03, 2023
Time: 2:30 pm to 4:00 pm

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid Semester Examination
Course No.: EEE 4305/EEE 4391
Course Title: Energy Conversion I

Winter Semester, A.Y. 2022-2023
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer **all 3 (three)** questions. Marks, corresponding POs, and corresponding COs have been written in brackets on the right. Programmable calculators are not allowed. Do not write on this question paper. Assume suitable values for any missing data.

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1. a) For the simplified dc generator depicted in Fig. 1(a), the fringing effect contributes an additional 10% area for the air–gap. $\mu_r = 3000$ for the ferromagnetic core and current per turn, $i = 0.5\ A$. Calculate for the resulting flux density in the air–gaps. (08) (PO1) (CO1)

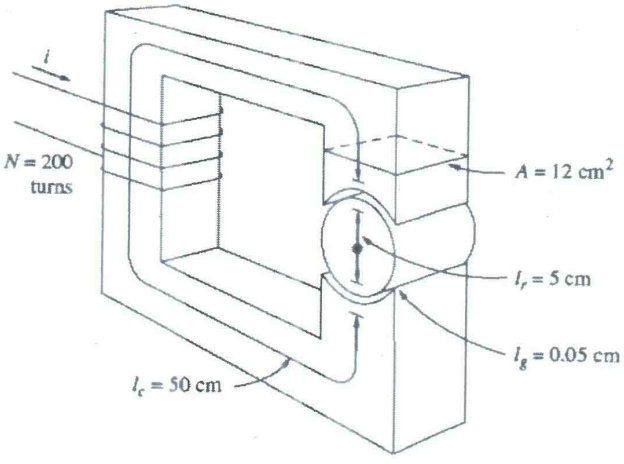

Fig. 1(a)

b) A 4-*pole, lap-wound, long-shunt, compound-wound* dc generator has useful flux per pole of 0.07 *Wb*. The armature consists of 220 *turns* each of 0.004 Ω. Resistances of the shunt and series fields are 100 Ω and 0.02 Ω respectively. The generator is running at 900 *rpm* with armature current of 50 *A*. Solve for: (06) (PO1) (CO1)
   i) The terminal voltage and
   ii) Power output in *kW*.

c) Sketch the hysteresis loop of a ferromagnetic core under the influence of a sinusoidal current. Mark, label, and explain different parameters of this loop. (06) (PO1) (CO1)

d) Illustrate the principles of manipulation of magnetic field to produce different machine actions in converting energy from one form to another. (05) (PO1) (CO1)

e) A linear dc machine started its operation at $t = 1\ s$, reached the steady–state at $t = 5\ s$, started operating as a motor at $t = 8\ s$, and reached steady–state as a motor at $t = 12\ s$. On a normal graph paper, sketch the response curves for: (05) (PO1) (CO1)

i) $v(t)$,
ii) $i(t)$,
iii) $F_{ind}(t)$, and
iv) $e_{ind}(t)$.

Assume suitable values for any relevant data.

2. a) Evaluate and sketch the cross–sectional view of a commutator segment of a practical dc generator. Explain the followings: (10) (PO2) (CO2)

i) Labeling of the names of different components of your sketch,
ii) Functions of these components,
iii) Usage of different types of materials for these component parts, and
iv) The operating principle of a commutator consisting of two semi–circular segments and two fixed contacts connected to the external circuit of the simple rotating loop generator with appropriate circuit diagrams.

b) Deduce the expression for voltage induced, e_{ind} in a simple rotating rectangular loop of wire placed inside a magnetic field produced by two bar magnets of opposite polarities having a constant–width air–gap. Your answer must include the following: (10) (PO2) (CO2)

i) Calculation of segment–wise and total induced voltage,
ii) Apparent view of the setup,
iii) View of field line distribution,
iv) Top view of the loop with e_{ind} polarities, and
v) Vector diagram of F_{ind} production.

c) For a dc generator, evaluate the different types of losses happening in a ferromagnetic core under the influence of direct and sinusoidal currents. Explain different practical solutions implemented to combat these loss heads. (05) (PO2) (CO2)

3. For a 4–pole dc generator with lap–wound duplex winding consisting of 14 coils, design for the followings: (20) (PO3) (CO3)

i) Winding parameter values and conductor connections at back and front end,
ii) A developed winding diagram,
iii) Appropriate brush positions,
iv) Appropriate coil diagram with parallel path connections, and
v) Appropriate equalizing connections.