

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

Date: December 5, 2023 (Tuesday)
Time: 1:30 pm to 4:30 pm

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

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

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

Winter Semester, A.Y. 2022-2023
Time: 3 Hours
Full Marks: 150

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.

1. a) With appropriate sketches, explain the key features of the external characteristics curve of a dc shunt generator. Explain the behavior of this machine after the breakdown point and the impact of breakdown point on a practical dc generator. (08) (PO1) (CO1)
- b) Sketch the power flow diagram of a dc shunt motor. Include percentage contributions in terms of full load loss for different loss heads in your sketch. (08) (PO1) (CO1)
- c) With proper justification, explain the different types of loss heads associated with a 1- ϕ transformer under no-load and on-load. Assume that there is no magnetic leakage in its' operation. (08) (PO1) (CO1)
- d) A 250 V dc shunt motor, runs at 500 rpm. The armature current is 50 A. Calculate the new speed if the torque is doubled. Assume armature resistance, $R_a = 0.2 \Omega$. (08) (PO1) (CO1)
- e) A 6-pole, 500 V wave-connected shunt dc motor has 1200 armature conductors and a useful flux/pole of 20 mWb. The armature and field resistances are 0.5 Ω and 250 Ω respectively. Solve for: (08) (PO1) (CO1)
 - i) Speed and developed torque when the motor draws 20 A from the supply mains. Neglect armature reaction.
 - ii) Useful torque, output in kW, and efficiency if magnetic and mechanical loss amount to 900 W.
2. a) Analyze the different characteristics curves of a separately excited dc generator. Based on your findings, explain the followings: (15) (PO2) (CO2)
 - i) Process of plotting all the characteristics curves in an E_g vs. I_f (Generated emf vs. Field Current) plane,
 - ii) Process of plotting all the characteristics curves in an E_g vs. I_a (Generated emf vs. Armature Current) plane,
 - iii) Practical necessities of these characteristics' curves, and
 - iv) Process of sketching drop reaction triangle and its' significance.

- b) Compare the different characteristics curves of shunt, series, and compound motors. Summarize their electrical and mechanical characteristics in a "Graph Paper". Based on your findings, recommend the usage of different dc motors for practical/laboratory purposes with proper justification. (15)
(P02)
(C02)
- c) Appraise the different speed control methods for a shunt dc motor. With necessary justifications, recommend the most preferred to least preferred method in terms of: (15)
(P02)
(C02)
- Obtaining maximum speed compared to rated speed,
 - Obtaining minimum speed compared to rated speed,
 - Best method in combating the impacts of armature reaction,
 - Associated power loss due to the application of a speed control method, and
 - Cost of the system.
- d) Compare the different methods of improving commutation of a dc generator. With necessary diagrams and sound reasoning, explain the followings: (15)
(P02)
(C02)
- Resistance commutation,
 - Interpoles and their principle of operation,
 - Comparative analysis of the merits and demerits of these two methods, and
 - Applicability of these methods based on system requirements.
- e) Evaluate the process of armature reaction of a 2-pole dc shunt generator. Based on your analysis, summarize the followings with appropriate sketches: (15)
(P02)
(C02)
- Nature of the magnetic field generated by the shunt field current,
 - Nature of the magnetic field generated by the armature current,
 - Nature of the resultant magnetic field after the occurrence of armature reaction,
 - Key takeaways from the armature reaction, and
 - Techniques implemented in combating negative impacts of armature reaction.
- f) Deduce the differences in the vector diagrams of a transformer having a resistance and leakage reactance with inductive and capacitive loads connected across secondary with proper sketches in terms of: (15)
(P02)
(C02)
- Voltage and current on primary side and
 - Voltage and current on secondary side.
3. You have been provided with 2 identical series motors with field resistances of $R_f = 100 \Omega$ each. Design 8 different setups with these motors to produce 8 different speeds. Your design must fulfill the followings: (20)
(P03)
(C03)
- At least 2 setups must have rheostatic speed control with a control resistor of 100Ω ,
 - At least 2 setups must have field divertors of 100Ω ,
 - At least 2 setups must have armature divertors of 100Ω , and
 - All the setups must be arranged according to the descending order of their speeds.