Department of Electrical and Electronic Engineering
EEE113 - Introduction to Electrical Engineering
Final Exam

25th Jan 2024, 14:45–16:15

Full Name : _____ Student ID: _____

Grade Table (for Lecturer use only)

Question	Points	Score
1	20	
2	15	
3	15	
4	50	
Total:	100	

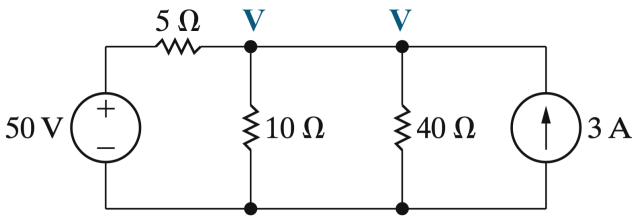
Instructions for Final Exam

Welcome to the final exam of EEE113 - Introduction to Electrical Engineering and good luck! Please read the following rules and confirm by signing that you have read and understood the rules before you receive your exam:

1. The final exam shall be conducted between 14:45 and 16:315. Exam duration is 90 minutes. Students must finalise the exam by delivering it before 16:15. Students are not allowed to leave the exam in the first 30 minutes.
2. Student ID cards shall visibly be on the edge of desks till the end of the exam. Students without the student ID cards or Turkish identity cards shall not be participated into the exam.
3. This is a closed-book exam which means that students are not allowed to take notes, books, or any other reference material into the exam. Throughout the exam, students shall not possess mobile phones and electronic devices that are capable of storing, receiving, or transmitting information or electronic signals, such as computerised watches.
4. Students are not allowed to take a glance at the exam questions until told to do so. Students shall not communicate with any other student under any circumstances during the exam period. A student, who cheats, tries to cheat during the exam, or is identified to be cheating after investigating exam documents, is given 0 (zero) for that exam and a disciplinary investigation is opened against the student.
5. All numerical values in the exam shall be calculated according to **two decimal digits**. Otherwise, there will be a penalty.
6. An incorrect answer to a question is awarded no marks with no consideration of any partial credit. Therefore, **no partial credit** will be given.

In recognition of and in the spirit of the above rules, I certify that I will neither give nor receive unpermitted aid on this examination.

Signature: _____



1. **(20 points)** Use the node-voltage method of circuit analysis to find the voltage **V** in the above figure.
2. **(15 points)** Compare traditional and future electric power systems.
3. **(15 points)** Hywind Scotland is the world's first commercial wind farm using floating wind turbines, situated 29 kilometres off Peterhead, Scotland. The farm has five 6 MW direct-drive turbines. The capacity factor of the wind farm is averaged as 54%. What is the annual energy production of the wind farm in GWh.
4. Suppose that you have a small house in the countryside which is **not** connected to the grid. The place enjoys 4 equivalent sun hours. Therefore, you have decided to install a **stand-alone** PV system to supply the demand of your house. Electrical needs of the house are summarised in the below table.

Load	Quantity	Power per Item (W)	Time of Use (h)	Type
Incandescent Lamp	4	25	3	DC
TV	1	100	2	AC
Laptop	1	100	1	AC
Refrigerator	1	75	24	AC

Design the system in accordance with the followings:

- Assume that the days of autonomy is equal to 2, the combined efficiency for the cables, the charge controller, and the battery system is 90%, and the stand-alone inverter efficiency is 95%.
- PV Module Characteristics:

P (W_p)	V_{mpp} (V)	I_{mpp} (A)	V_{oc} (V)	I_{sc} (A)
250	30.78	8.13	37.44	8.90

- MPPT Charge Controller Specifications:

V_{max} (V)	I_{max} (A)	$V_{operational}$ (V)
100	30	12/24

- Battery Features:

Depth of Discharge (%)	$V_{battery}$ (V)	$C_{battery}$ (Ah)
70	12	135

Answer the following questions according to the above instructions.

(a) **(20 points)** Calculate how many panels are required to supply the demand and determine the connection configuration of panels.

(b) **(20 points)** Calculate how many batteries are necessary for your design and determine the connection configuration of batteries.

(c) **(10 points)** Calculate size of the stand-alone inverter for your design.