Istanbul Technical University
Faculty of Electrical & Electronics Eng.
Electrical Engineering Dep.

İTÜ

ELK331E - Power Electronic Circuits
Assoc. Prof. Dr. M. Onur GULBAHCE
Midterm 1 - 11.11.2024

Name-Surname: _____
Student ID Number: _____

Questions:	1	2	3	4	Total
Score:	20	30	30	30	110

BEFORE THE EXAM ☺

- You may use formula sheets prepared in your own handwriting on one side of an A4-sized paper.
- The order of questions does not correspond to their level of difficulty. It is recommended that you do not begin answering until you are certain you have read and understood all the questions.
- Exam papers with improbable errors are considered as cheating.
- The parts whose logical structure is not understood are not included in the assessment.
- Exam duration is 120 minutes.
- Take home parts have to be submitted until 17.11.2024 via NINOVA.

QUESTIONS

20 1. a) What is power electronics, and what are its application areas?

b) What are the switching devices used in power electronics?

c) Compare the basic power electronics switching devices in terms of current, voltage, and switching frequency.

30 2. A single-phase half-wave uncontrolled rectifier supplies a DC motor from a 230V / 50Hz AC power source. The parameters of the DC motor are $R \cong 0\ \Omega$, $E = 40V$, and $L = 40\ mH$.

a) Draw the topology of the rectifier.

b) Write the load current equation.

c) Determine the conduction interval of the diode, neglecting the forward voltage drop.

d) Draw the waveform of the load voltage and current.

e) Calculate the average value of the load voltage.

Take Home Section: Perform the simulation of the circuit in MATLAB/Simulink and add the necessary calculation blocks:

a) Calculate the average value of the load current and voltage.

b) Calculate the RMS value of the load current and voltage.

c) Calculate the mechanical power induced in the DC motor.

d) Calculate the power factor of the circuit.

e) Plot the waveforms of the load current and voltage.

30 3. A single-phase full-wave controlled rectifier with a freewheeling diode supplies an highly-inductive load from a 230V / 50Hz grid. The load parameters are $R = 2.5\ \Omega$ and $L >> R$. The ripple of the load current will be neglected. The firing angle α is 90°.

a) Draw the topology of the rectifier.

b) Draw the waveform of the load voltage and current.

c) Draw the waveform of the source current and voltage.

d) Calculate the average and RMS values of the load voltage.

e) Calculate the form factor and ripple factor of the output voltage.

f) Calculate the RMS value of the source current.

g) Calculate the power factor.

Take Home Section: Perform the simulation of the circuit in MATLAB/Simulink. Take the load values as $R = 2.5\ \Omega$ and $L = 5\ mH$, and add the necessary calculation blocks:

a) Plot the waveform of the load voltage and current.

b) Plot the waveform of the source current and voltage.

c) Calculate the average and RMS values of the load voltage and current.

d) Calculate the form factor and ripple factor of the output voltage.

e) Calculate the RMS value of the source current.

30 4. A single-phase uncontrolled full-wave rectifier is supplied by a 230V/50Hz grid. A load with $R = 120\ \Omega$ is supplied with a filter capacitor of $C = 150\ \mu F$.

a) Draw the topology of the rectifier.

b) Calculate the angle values at which the diodes become reverse biased (θ) and forward biased ($\pi + \alpha$).

c) Draw the waveform of the load voltage and current.

d) Calculate the average value of the load voltage (Hint: Use the output voltage ripple value).

e) Calculate the output voltage ripple. Determine the required value of C to reduce this ripple to 10% of the DC value of the output voltage.

Take Home Section: Perform the simulation of the circuit in MATLAB/Simulink and add the necessary calculation blocks:

a) Plot the waveform of the load voltage and current.

b) Plot the waveform of the source current and voltage.

c) Calculate the average and RMS values of the load voltage and current.

d) Calculate the form factor and ripple factor of the output voltage.

e) Calculate the RMS value of the source current.

Wishing you success! ☺