University of Ruhuna- Faculty of Technology

Bachelor of Engineering Technology Honours Degree
Level 4 (Semester II) Examination, November/December 2023
Academic year 2021/2022

Course Unit: ENT4223 Power Electronic and Applications

Duration: 3 hours

- The medium of this examination is **English**.
- This is a **closed book** examination.
- This examination consists of **five (05)** questions that are given equal marks.
- Answer **all five (05) questions**.
- This is a **closed book** examination.

01.

a) A single-phase uncontrolled full bridge rectifier is supplied with a sinusoidal AC voltage of 230 V at a frequency of 50 Hz. The load is a resistive load with a resistance of 10 Ω.

i. Draw the circuit diagram of the single-phase uncontrolled diode rectifier.

ii. Draw the output voltage and current waveforms.

iii. Calculate the followings,

a. Mean value of the output voltage

b. Output power.

(10 marks)

b) A three-phase full bridge uncontrolled diode rectifier is connected a balanced three-phase supply with line-to-line voltage of 400 V (RMS) at a frequency 50 Hz. The load is a resistive load with a resistance of 15 Ω.

i. Draw the circuit diagram of a three-phase full bridge uncontrolled diode rectifier.

ii. Draw the output voltage waveform, and output current waveform for one phase.

iii. Calculate the following parameters,

a. Mean value of the output voltage.

b. Output voltage ripple frequency.

(10 marks)

02.

a) A single-phase fully controlled thyristor bridge rectifier is supplied 230 V, 50 Hz. The source inductance and the thyristor voltage drops are negligible. Assuming continuous conduction,

   i. Draw the circuit diagram of the above system.

   ii. When considering firing angle as 30°,

      a. Show the output voltage waveform.

      b. Calculate the mean value of the output voltage.

      c. Calculate the displacement factor.

   iii. If supply source inductance is 0.9 mH/line, redraw the output voltage waveform for a firing angle of 30°.

   iv. Calculate the overlap angle (u) for a load current of 30 A and a firing angle of 30°.

(14 marks)

b) A three-phase fully controlled thyristor bridge rectifier is supplied 400 V, 50 Hz three-phase AC power supply. The source inductance is negligible.

   i. Draw the circuit diagram of the above system.

   ii. Calculate the mean value of output voltage.

   iii. Calculate the voltage ripple frequency.

(6 marks)

03.

a) List down two basic types of DC to AC inverters based on the operating source.

(2 marks)

b) Write down equations defining all terms for follows,

   i. Depth of Modulation

   ii. Carrier ratio

(4 marks)

c) A single-phase voltage source inverter (VSI) is operating with the supply side voltage of 220 Vdc.

   i. Draw the circuit diagram of the above system.

ii. Considering VSI is in the operation of the square wave switching,

a. Draw the output voltage waveform.

b. Calculate the RMS value of the fundamental component of the output voltage.

iii. Consider the VSI is in the operation of the square wave unipolar PWM switching with carrier ratio of 6 and depth of modulation of 80%.

a. Draw the unipolar PWM modulator circuit, considering carrier signal as V_C, reference signal as V_R and switching signals as S1, S2, S3, and S4.

b. Draw the output voltage waveform with an appropriate values of voltage magnitudes.

c. Calculate the RMS value of the fundamental component of the output voltage.

(14 marks)

04.

a) Draw the circuit diagram and explain the functionality of the buck boost converter.

(4 marks)

b) Draw following waveforms for buck boost converter considering converter is operating in a continuous conduction mode under the following conditions: input voltage V_d = 100 V, duty factor D = 0.75, output power P_o=600 W inductance L=100 µH and f_s = 400 kHz. Assume ideal components.

i. Calculate the following parameters,

a. Output voltage

b. Output ripple current

c. Maximum output current

d. Input current. State any assumptions you made.

ii. Draw following waveforms,

a. Output voltage

b. Inductor voltage

c. Inductor current

(16 marks)

05.

a) Explain the requirement of power electronics for High Voltage Direct Current (HVDC) transmission.

(4 marks)

b) List down two advantages of switching power supplies over linear power supplies.

(4 marks)

c) Provide the circuit diagram for flyback converter and explain the advantages of flyback converters.

(4 marks)

d) Draw the block diagram for a motor drive and list down basic two factors to vary the power electronic converter.

(4 marks)

e) Explain the working principle of the "Induction Heating" using examples.

(4 marks)

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