

## Power Electronics (EE3203)

### 1) Introduction

### 2) Semiconductor Devices

Classification, Behavioural classification, Physical, Classification, Silicon Controlled Rectifier Symbol, terminals, and their method of connection, Static v-i curve, Features of SCR behavior when gate turn is used (a) Gate turn on conditions, pulse duration (b) latching current, Turning off an SCR — holding current — forced commutation — natural commutation, Other methods of turn-on (a) dv/dt turn-on (b) Increasing junction temperature (c) Irradiating the junction, Dynamic characteristics — turn-on transients (a) Delay time (b) Voltage fall time, Dynamic characteristics — turn-off transients, Gate characteristics, SCR ratings

### 3) Features of power processing systems

Ideal waveforms of DC and AC sides, Figures of merit - DC side (a) ripple factor (b) average value, Figures of merit - AC side, (a) Harmonic factor (b) Distortion factor (c) THD (d) Power factor (e) Crest factor, Power in switching circuits, Efficiency

### 4) Simple circuits

SCR with a R load, R-L load, general solution, R-L load and freewheeling diode — continuous and discontinuous conduction Modes

### 5) AC to DC conversion systems

Two-pulse & three-pulse Midpoint converters- circuits and method of triggering — triggering angle — conduction angle — extinction angle, R load — average voltage — control characteristic — mains current — various figures of merit—comparison with single pulse converter—power and power factor — reactive power requirement, R-L load, infinite inductance — ac side current waveform — figures of merit — average voltage — inverter mode, Commutation analysis — overlap angle — commutation drop, Factors affecting overlap angle, inverter mode of operation, inverter limit, R-L load with finite time constant — conditions for continuous and discontinuous conduction — determining L for a particular ripple, Use of freewheeling diode, R-L-E load — L for continuous conduction in case of L-E load.

Four-quadrant operation of DC machine, Single-phase bridge converter - Connection — series connection of two 2-pulse midpoint converters, R load — dc and ac performance, R-L load with infinite inductance — dc and ac performance, Commutation, Inverter mode of operation,

Three-phase bridge converter - Circuit connection — series connection of two 3-pulse midpoint converters — sequence of triggering and conduction, R-load — limits of continuous and discontinuous conduction — average voltage — line current, Commutation — analysis — voltage drop, Inverter mode of operation — inverter limit

### 6) DC to DC Conversion Systems

Buck Converter - Circuit configuration, working and waveforms — voltage gain — inductor current ripple — relation between input and output currents, Discontinuous conduction mode — voltage gain, Use of SCR in buck converter — commutation circuit analysis, Estimation of output voltage ripple

Boost Converter- Circuit configuration, working and waveforms — voltage gain — inductor current ripple — relation between input and output currents, Discontinuous conduction mode — voltage gain, Estimation of output voltage ripple,

Four quadrant DC drive

Buck-Boost Converter - Circuit configuration, working and waveforms — voltage gain — inductor, current ripple — relation between input and output currents, Discontinuous conduction mode — voltage gain, Estimation of output voltage ripple

Cuk Converter - Circuit configuration, working and waveforms — voltage gain — inductor current ripple — relation between input and output currents, Discontinuous conduction mode — voltage gain, Estimation of output voltage ripple

## 7) DC to AC conversion systems

Inverter configuration, numbering of switches,  $180^\circ$  conduction with resistive load — waveforms,  $180^\circ$  conduction with R-L load — need for freewheeling — waveforms,  $120^\circ$  conduction, Sinusoidal PWM (a) Understanding the scheme (single phase half bridge), (b) Frequency and amplitude modulation index, (c) Bridge converters — Unipolar and Bipolar switching, (d) Three phase bridge, (e) Harmonics in the output voltage, (f) Restriction on values of  $m_f$ , Programmed PWM — Calculation of notch angles

## 8) AC to AC Conversion Systems - AC Voltage Controller

Configuration and operation, R-load, R-L load — control range, Application to on-load tap changing

## Assessment [Marks indicated are tentative]

- (i) Mid-term exam (**25 Marks**)
- (ii) Assignments/Simulations (**25 Marks**)
- (iii) End Semester Exam (**50 Marks**)

## Books

- 1) Mohan.N, Undeland.T.M and Robbins.W.P, Power Electronics: Converters, Applications and Design, John Wiley & Sons, USA, 1989.
- 2) Rashid.M.H, Power Electronics, Circuits, Devices and Applications, Prentice Hall, NJ, 1988.
- 3) L.Umanand, Power Electronics Essentials and Applications, Wiley, 2009.