

BITS PILANI- K.K. BIRLA GOA CAMPUS
SEMESTER – II, 2023-2024
Course Handout

Date: 17.01.2024

In addition to part-I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : EEE F342/INSTR F342
Course Title : Power Electronics
Instructor-in-Charge : Sudarshan Swain
Instructor (Lecture) : Ramesh Vasani
Instructors for (Lab) : Narayan Suresh Manjarekar; R. Gopika; Anagha Rajendran K P;
Rishikesh Girish Datar; Suraj S; Neeraj Kumar Bhaskar
Lab Staff : Prakash Lamani, Ramesh Bhattu

1. Course Description: The course covers the following topics:

Introduction to power electronics & identifying their applications; Introduction to switching circuits; Switch realization using semiconductor devices; Study of DC to DC converters, uncontrolled & phase-controlled rectifiers, square wave and PWM controlled inverters, phase-controlled AC to AC converters & cyclo-converters and resonant converters; and Ancillary issues such as gate drive circuits and protection circuits.

2. Scope, objective and outcome of the course:

The scope of the course covers the study of the aspects mentioned above. Its objectives are as follows:

- To explain to students how different electronic devices act as switches and how their working is influenced by passive elements such as resistor, inductor and capacitor.
- To present them the analysis & design of different types of power converters operating in steady state.
- To enable them to design a few gate driver & protection circuits
- To provide students an opportunity to gain hands-on/simulation experience on the following through lab experiments – **a.** Performing steady state analysis of a few of the converters, **b.** Generating control signals for these converters and **c.** Performing measurements in isolated high voltage (HV) setups.

The outcomes of this course are that, after undertaking it, the students will be able to explain how different power electronic switches work in the presence of various passive elements, perform the steady state analysis of a few power converters, devise circuits for control signal generation as well as for gate drive & protection and also perform measurements in HV setups.

- 3. Prerequisites:** To get a good understanding of this course, the students should know the basics of Electrical Sciences, Signals & Systems and Electrical Machines.
- 4. Text Book:** N. Mohan, T. M. Undeland, and W. P. Robbins, *Power Electronics: Converters, Applications and Design*, John Wiley & Sons Inc. 2012, third edition.

5. Reference Books:

1. Muhammad H. Rashid, *Power Electronics: Circuits, Devices, and Applications*, Pearson, Third Edition, 2004.
2. L.Umanand, *Power Electronics: Essentials & Applications*, Wiley India, 2009, First edition.
3. Robert.W. Erickson and Dragan Maksimovic, *Fundamentals of Power Electronics*, Springer, 2001, Second Edition.

6. Course Plan

Lecture	Topic	Coverage	Covered from
01 - 04	Power electronic systems	Introduction, non-sinusoidal waveforms in steady state, Fourier analysis, line current distortion, power and power factor, three phase systems, inductor and capacitor response.	T: 1.1 – 1.7, 3.1 - 3.2.5.1, 5.5
05 - 06	Power semiconductor switches	Overview, Power Diodes, Bipolar Junction Transistor, Power MOSFETs, Thyristors and Gate Turn-Off Thyristors & Insulated Gate Bipolar Transistors; Desired characteristics in controllable switches.	T: 2.1 - 2.12
		Realization of switches using semiconductor devices	R3 : 4.1 - 4.4
07 - 10	AC to DC converters (Rectifiers)	Uncontrolled rectifier configurations: single phase and 3 phase rectifiers, commutation overlaps.	T: 5.1 – 5.3.2, 5.6 - 5.6.2
11 - 15		Phase controlled rectifier configurations: single phase and 3 phase rectifiers, commutation overlaps, inversion in phase controlled converters; Single phase and three phase semi converters	T: 6.1 – 6.4.4, R1: 5.3, 5.8
16 - 20	DC to DC converters	Steady state analysis and design of Buck, Boost, Buck-Boost converters, Cuk converter	T: 7.1 – 7.6, R1: 9.7.1 - 9.7.4
21		Isolated converter: Forward converter	T: 10.4
22 - 29	DC to AC converters (Inverters)	Single-phase and three-phase inverters, voltage control of inverters, blanking time and its effects, current source inverters, series loaded and parallel loaded series resonant inverters	T: 8.1 - 8.5, R1:10.1 - 10.7, 10.11, 11.2.3 - 11.2.4, R2: 6.6 -6.7
30 - 34	AC to AC converters	ON-OFF control, phase control, single phase & three phase ac to ac controllers, cyclo-converters	R1: 6.1 to 6.7, 6.10
35 - 37	Introduction to resonant converters	Basic resonant topologies, ZCS and ZVS resonant converters	T: 9.1 - 9.3, 9.5, R1: 11.6, 11.7
38	Driving circuits & protection circuits	Snubber circuits for different devices.	T: 27.1 to 27.8
39 - 40		Base drivers for Power BJTs; gating circuits for thyristors; driving circuits for insulated gate devices.	T: 28.1 – 28.6

7. Laboratory Components

- i) Introduction to isolated and high voltage measurement: Uncontrolled bridge rectifier and controlled half-wave rectifier.
- ii) Study of single-phase semi-controlled and fully controlled rectifier.
- iii) Study of single-phase AC/AC converters.
- iv) Study of step-down converter.
- v) Study of boost converter.
- vi) Study of forward converter.

8. Evaluation Scheme:

Evaluation Component	Duration	Weightage (%)	Date and Time	Evaluation type
Midsemester Examination	90 min	25	16/03/24, (Saturday 4:00 PM - 5:30 PM)	CB
Theory Quizzes (1 Best out of 2 Quizzes)	To be announced	12	Will be announced later	OB
Assignment	To be announced	08	Will be announced later	OB
Comprehensive Examination	180 min	30	13/05/24 (FN)	CB
Laboratory Reports	-	12	-	OB
Laboratory Quiz	To be announced	05	Will be announced later	OB
Laboratory Comprehensive Examination	To be announced	08	Will be announced later	CB

CB: Closed Book

OB: Open Text Book and/or handwritten class notes (in **hard-copy** format) only.

9. Make up policy:

- Make up will be granted only on genuine grounds, subject to the discretion of IC.
- For Theory quizzes one best of two quizzes will be considered.
- No MAKE-UP will be granted for Theory Quizzes. No MAKE-UP will be granted for the assignment.

10. **Chamber Consultation Hour:** Will be announced in the lecture hour.

11. **Notices:** Notices regarding this course will be displayed on Moodle course webpage.
<https://quantaaws.bits-go.a.ac.in/course/view.php?id=2086>