FUNDAMENTAL OF POWER ELECTRONICS

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INTENDED AUDIENCE : Undergraduate and post graduate, including research students, with electrical and electronics engineering background would benefit from the course. Those with background in energy science and engineering and system and control disciplines may also benefit. Industry professionals and researchers in R&D stream will also benefit.

PRE-REQUISITES : Electrical and electronic circuits, network theory and basics of semiconductor physics.

INDUSTRIES APPLICABLE TO : All industries directly or indirectly using power electronics technology may find the course relevant.

COURSE OUTLINE :

The course introduces basics of power electronic devices and converters. Working principles, operating modes and analysis of AC-DC and DC-DC converters will be covered in detail. A flavour of DC-AC inverter will be introduced at the end of the course. This course uses SPICE simulation as a means for understanding and gaining more insight into the circuits. Control of power electronic converters will be explained.

ABOUT INSTRUCTOR :

Prof. L. Umanand is a faculty at the Department of Electronics System Engineering (DESE) of Indian Institute of Science, Bangalore. He has been teaching, guiding and consulting in power electronic converters for more than two decades. His area of research are in power conversion, renewable energy systems and modelling.

COURSE PLAN :

Week 1 : Ideal switch, diode static characteristics, diode dynamic characteristics, reading the diode datasheet, thermal dissipation, heatsink design, diac and triac.
Week 2 : Bipolar junction transistor - operation, static and dynamic characteristics, loss calculation, safe operation area, reading the datasheet, parallel operation, darlington connection.
Week 3 : MOSFETs and IGBTs - operation, static and dynamic characteristics of MOSFET and IGBT, parallel operation, loss calculation and simulation.
Week 4 : Rectifier - Capacitor filter, circuit operation and waveforms, designing the circuit, setting up for simulation in ngSpice, simulation of circuit.
Week 5 : Inrush current limiting in rectifier-capacitor filter circuits, resistor solution, thermistor solution, transformer solution, MOSFET solution, relay and contactor solution, power factor concepts and measurement of power factor for rectifier capcitor filter circuit.
Week 6 : Linear DC -DC converter or linear regulators, shunt regulator, operation, design and applications, series regulator, operation and design, improvement solutions, datasheet study.
Week 7 : DC-DC switched mode converters : Buck, Boost and buck-boost converters, operation, waveforms, equations and simulation in ngSpice.
Week 8 : Forward converter operation, waveforms, core resetting methods, simulation in ngSpice, Inductor deisgn by area product approach, Flyback converter, operation and waveforms.
Week 9 : Magnetics design, permeance, inductor value and energy storage, inductor design, transformer design area product approach,
Week 10 : Push pull, half bridge and full bridge circuits, operation and waveforms, simulation example
Week 11 : Drive circuits, BJT drive requirements, drive circuit non-isolated, drive circuits isolated, MOSFET drive requirements, drive circuit non-isolated and isolated, series snubber, shunt snubber.
Week 12 : Close loop control, current control, slope compensation for current control, single phase inverter with sinusoidal PWM, simulation example