Module (Course Syllabus) Catalogue

2023-2024

College/ Institute	**Erbil Technology College**	
Department	**Department of Electricity**	
Module Name	**Advanced Power Electronics**	
Module Code	**APE401**	
Semester	**4**	
Credits	**7**	
Module type	**Core**	
Weekly hours	**5**	
Weekly hours (Theory)	**(2)hr Class**	**(86)hr Workload**
Weekly hours (Practical)	**(3)hr Class**	**(118)hr Workload**
Lecturer (Theory)	**Farah A. Abed**	
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Lecturer (Practical)	**Farah A. Abed**	
E-Mail & Mobile NO.	**Farah.abed@epu.edu.iq 07503527165**	

Course Book

Course Description	This is the 4th semester in Advanced Power Electronics. Students will learn about specific areas of application and the reasons Power Electronics is becoming popular in areas traditionally occupied by analog electronics. The course will cover applications in conversion and control of power using Power semiconductor devices, physics of their structure and operation and passive components in power circuits. Students will also learn the principles governing the operation of converters, different standard topologies, applications in power systems, motor drives, and applications in renewable energy sources.
Course objectives	The course is prepared for final class students. It's highlighting on Power Electronic devices, its characteristics. Important circuit component design and analysis concepts. Controlled and uncontrolled phase rectifier circuits. Types of transistors and their applications. DC to DC converter. DC to AC inverter. IC circuits. Operational Amplifiers and their applications. Motor drives and Power electronic applications with renewable energy conversions.
Student's obligation	**Respect** A student has an obligation to exhibit honesty and to respect the ethical standards of the profession in carrying out his/her academic assignments. Without limiting the application of this principle. **Attendance** Missed classes will not be compensated including the quizzes and the scheduled assignments. The students will lose marks on unattended classes with quizzes unless a legal document or authorized leave is presented which should explain the excuse of the absence. However, the absent student should take the responsibility for making up the missed lecture. **The lectures format** The lectures are divided on four weekly hours (two hours theoretically and three hours practically). Mainly, the first two theoretical hours will be dedicated for the topic backgrounds and the main principles. Notes and handouts are given to the students containing the detail of the theoretical topics. Theoretical lectures will be assisted by presentations using white board and data show. Discussion time is provided for the students for questions. The first practical hour will be dedicated for how to works in the laboratory, health and safety, how to use equipment,

	boards, components, and wire connection to do experiments and reports. Students should submit every week a report about the previous experiment. **Questions** Asking questions about unclear material is an important part of the classroom experience. It is not uncommon for students to have similar difficulties, so speaking up will help everyone understand the discussed information. Teachers can also benefit from a student's questions. By finding out what subjects are hard to understand, instructors can adjust their lectures to clear up confusing topics. **Assignment** A student must submit the assignment on **moodle** app. every week and also write a report about what he/she was studied in the laboratory.
Assessment scheme	16% Mid Term (Theory and practical) 4% Quiz 40% Assignment (report, paper, homework, seminar...) 25% final practical 15% final theory
Specific learning outcome:	After taking this course, students have ability to: 1. Understand the need, use and limitations of Power Electronics 2. Appreciate the linkage of Power Electronics with electromagnetics, circuits, devices, electronics, feedback, control, power systems, machines and emerging application areas like renewables, smart grids and high frequency applications. 3. Understand the factors affecting choice of devices in power electronics Lahore University of Management Sciences.
Course References:	1. Thomas L. Floyd, Electronic devices, sixth edition, Copyright @ 2004, 2002, 1999, 1996. 1992, 1988, 1984 by Pearson Education, Inc., Upper Saddle River, New Jersey Pearson Prentice Hall. 2. S. CHAND, R.S.SEDHA,A Textbook of Electronic circuits 2007. 3. Denis Fewson, Introduction to power electronics , Printed and bound in Great Britain by J W Arrow smith Ltd, Bristol , 1998. 4. Muhammad H. Rashid, SPICE for Power Electronics and Electric Power, Second Edition, Published in 2006 by CRC Press.Handbook-Six Volume Set, CRC press.

Course topics (Theory)	**Week**	**Learning Outcome**
OPERATIONAL AMPLIFIERS, Typical packages, ideal op-amp - practical op-amp, Input Signal Modes, Negative Feedback, Op-Amp Gains.	1	

APPLICATIONS OF OPERATIONAL AMPLIFIERS, Inverting Amplifier, non-inverting Amplifier, Inverting Summing Amplifier, non-inverting Summing Amplifier, Integrators, Differentiator, Zero-level Detection, Nonzero-Level Detection.	2	
Thyristor, Types of Thyristors, silicon-controlled rectifier (SCR), construction, characteristics, Thyristor turn On & OFF conditions, SCR equivalent circuits, Gate turn On& OFF characteristics.	3	
Gate Triggering Methods, R – Triggering, RC – Triggering, UJT - Triggering.	4	
Thyristor Commutation Techniques, Natural Commutation, Forced Commutation, MOS-controlled Thyristors, Static Induction Thyristors, Optically Triggered Thyristors, Diac, Triac.	5	
Naturally Commutating AC to DC Converters, Fully Controlled rectifiers Half controlled rectifiers, Single-phase, half-wave controlled circuit with an R-L load, Single-phase, full-wave controlled rectifier circuit with an R-L load, Three-phase half-controlled converter.	6	
INVERTERS, Introduction, Single-phase inverter, Half-bridge with resistive load, Half-bridge with purely inductive, Full-wave bridge inverter, Three-phase bridge inverters.	7	
DC-DC Converters: choppers, Step-Down (Buck) Converter, Choppers: Step-Up (Boost) Converter, Buck-Boost Converter.	8	
Power Electronics and Drives, Power Electronics and Drives - Induction Motor Drives.	9	
Doubly Fed Induction Generator(DFIG).	10	
Dc Motor Drives.	11	
Wind- Energy Conversion.	12	
Practical Topics	**Week**	**Learning Outcome**
Operational Amplifier (OP-Amplifier) applications as inverting amplifier, Operational Amplifier (OP-Amplifier) applications as non-inverting amplifier.	1	
Operational Amplifier (OP-Amplifier) applications as multivibrator amplifier, OP-amp. As zero crossing detector	2	

SCR characteristics.	3	
DIAC characteristics, TRIAC characteristics.	4	
SCR and RC phase control, UJT- SCR phase control	5	
SCR DC motor control.	6	
PUT – SCR power control	7	
SCS characteristics.	8	
SCS single phase rectifier circuits.	9	
SCS three phase rectifier circuits.	10	
SCS DC motor forward/reverse control.	11	
SCS trigger circuit, SCS inverters.	12	

Academic year: 2018 – 2019
Final exam / First attempt

Q1/ Answer five of the following:

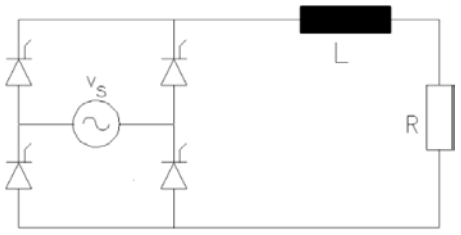
1- By relation show the condition of the range values of resistance(R) that ensure firing of the UJT.
2- By drawing show the open loop frequency response curve (gain bandwidth) of OP-amp.
3- By relation show the condition that makes BJT saturated in the circuit.
4- By drawing show the characteristic curve of TRIAC.
5- By drawing show the circuit of over voltage protection of SCR.
6- By relation show the difference of V_{dc} in the three phase half wave and full wave uncontrolled rectifier.

(10 Marks)

Q2/A- For a single phase full wave bridge controlled rectifier circuit, supplied with (340sin314t), R=20Ω and inductive L=200mH. If firing angle ($\alpha=60^o$) and conduction angle ($\theta=135^o$). Find:

For discontinuous case:

1- Phase angle (ø**).** 2- Average load voltage (V_{dc}**).**
3- Average load current (I_{dc}).



For continuous case:

1- Average load voltage (V_{dc}**).**
2- Average load current (I_{dc}).

(15 Marks)

B- Draw the characteristic curve of IGBT with showing the operation regions.

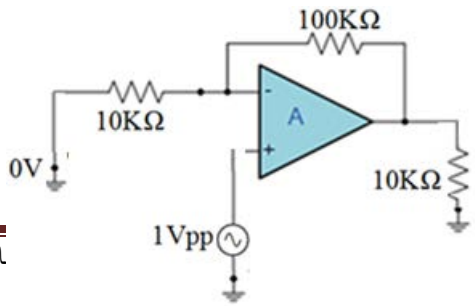
(5 Marks)

Q3/ **A-** For the circuit shown, find:

(10Marks)

1- The closed loop gain (A_{cl}).
2- Common-mode rejection ratio (CMRR).
3- Maximum operating frequency (f_{max}).

If (A_{cm}=0.001 and slew rate= 0.5V/μs).



B- For D-MOSFET, I_{DSS}=18mA, and $V_{GS\,(ON)}$ =10V:
(10Marks)

1- Is this device n-channel or p-channel?
2- Determine I_D for V_{GS}=4V.
3- Determine I_D for V_{GS}=-4V.

C- Write down modes of thyrisistor (SCR) triggering turn ON and turn OFF**.**
(10Marks)

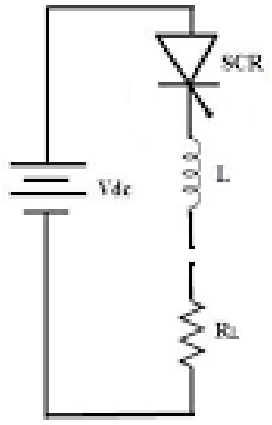
Q4/**A-** For a buck-chopper supplied by a 200Vdc have ON time of 30ms and OFF time of 10ms. Determine:

1- Chopper duty cycle (D). 2- Chopper frequency (f). 3-output load voltage (V_{dc}).

B- What is the difference between differentiator and integrator OP-amp by: feedback- output waveform voltage- output voltage (V_{OUT}).

Q5/**A-** For the circuit below: ***(10 Marks)***

If R=20Ω, L=0.5H, V_S=100Vand the latching current of SCR I_L=20mA is fired by the pulse of width 50μs. Determine the SCR triggers or not.



B- A half bridge inverter has Vb1=Vb2=50V, the load resistive is 10Ω, inverter frequency is 50 Hz. Determine the load power dissipation and sketch the load current diagram.

GOOD LUCK

Lecturer

Prof. Dr. Farah A. Abed