Ministry of Higher Education and
Scientific Research - Iraq
Al-Furat Al-Awsat Technical University
Al-Musaib Technical College
Department of Electrical Engineering Techniques

MODULE DESCRIPTOR FORM
نموذج وصف المادة الدراسية

Module Information
معلومات المادة الدراسية

Module Title	**DC POWER CONVERSIONS**	**Module Delivery**	
Module Type	CORE	✓ **Theory** **Lecture**	
Module Code	ATU٢٣٠٥٢	✓ **Lab** **Tutorial**	
ECTS Credits	5	✓ **Practical**	
SWL (hr/sem)	125	✓ **Seminar**	
Module Level	٣	**Semester of Delivery**	1
Administering Department	**DEPARTMENT OF ELECTRICAL ENGINEERING TECHNIQUES**	**College**	**AL-FURAT AL-AWSAT TECHNICAL UNIVERSITY/AL-MUSAIB TECHNICAL COLLEGE**
Module Leader		**e-mail**	
Module Leader's Acad. Title		**Module Leader's Qualification**	PhD
Module Tutor	None	**e-mail**	None
Peer Reviewer Name	None	**e-mail**	None
Review Committee Approval	13/06/2023	**Version Number**	1.0

Relation With Other Modules
العلاقة مع المواد الدراسية الأخرى

Prerequisite module	NONE	**Semester**	
Co-requisites module	None	**Semester**	

Module Aims, Learning Outcomes and Indicative Contents
أهداف المادة الدراسية ونتائج التعلم والمحتويات الإرشادية

Module Objectives
أهداف المادة الدراسية

Students will learn the principle of ;

١. Understand the fundamental principles and concepts involved in DC power conversion, including voltage and current regulation, power transfer efficiency, and control techniques.
٢. Identify and analyze different DC power converter topologies, such as buck converters, boost converters, buck-boost converters, and flyback converters, understanding their working principles, advantages, and limitations.
٣. Design and analyze DC power converters for specific applications, considering parameters such as voltage and current requirements, efficiency,

and size constraints. Select appropriate components and determine control strategies for achieving desired performance specifications.

٤. Develop proficiency in modeling and simulation techniques for DC power converters, using software tools or programming languages to analyze converter behavior under different operating conditions and evaluate performance metrics.

٥. Understand various control techniques used in DC power converters, such as pulse width modulation (PWM), voltage mode control, current mode control, and hysteresis control. Analyze the stability and dynamic response of control loops.

٦. Familiarize with passive and active components used in DC power converters, including inductors, capacitors, diodes, MOSFETs, and IGBTs. Understand their characteristics, selection criteria, and their impact on converter performance and reliability.

٧. Gain awareness of practical considerations and challenges associated with DC power converter implementation, such as thermal management, electromagnetic interference (EMI), component stress, and protection mechanisms. Learn techniques to mitigate these issues.

٨. Evaluate the efficiency and power quality aspects of DC power converters, including efficiency calculations, harmonic content analysis, power factor correction, and techniques to reduce switching losses.

٩. Understand the integration of DC power converters in larger systems, such as renewable energy systems, electric vehicles, and power electronic interfaces. Gain awareness of the interaction between converters and other system components.

١٠. Develop troubleshooting and problem-solving skills to diagnose and rectify issues related to DC power converters. Analyze and interpret experimental data, identify sources of errors or failures, and propose solutions.

By achieving these module objectives, students will gain a comprehensive understanding of DC power converters, enabling them to design, analyze, and implement efficient and reliable power conversion systems in various applications.

١. Understanding of DC Power Conversion Principles: Students should be able to comprehend the fundamental principles and concepts involved in DC power conversion, including voltage and current regulation, power transfer efficiency, and control techniques.

٢. Knowledge of DC Power Converter Topologies: Students should be familiar with various DC power converter topologies, such as buck converters, boost converters, buck-boost converters, and flyback converters. They should understand the working principles, advantages, and limitations of each topology.

٣. Ability to Design and Analyze DC Power Converters: Students should be capable of designing and analyzing DC power converters for specific applications. They

Module Learning Outcomes مخرجات التعلم للمادة الدراسية	should be able to calculate component values, select appropriate switching devices, and determine the required control strategies for achieving desired performance specifications. ٤. Proficiency in Modeling and Simulation: Students should be proficient in using software tools or programming languages to model and simulate the behavior of DC power converters. They should be able to analyze converter performance under different operating conditions, evaluate transient responses, and assess the impact of parameter variations. ٥. Understanding of Control Techniques: Students should have a solid understanding of different control techniques employed in DC power converters, such as pulse width modulation (PWM), voltage mode control, current mode control, and hysteresis control. They should be able to analyze the stability and dynamic response of the control loops. ٦. Knowledge of Passive and Active Components: Students should be familiar with the characteristics and selection criteria of passive components (e.g., inductors, capacitors) and active components (e.g., diodes, MOSFETs, IGBTs) used in DC power converters. They should understand their impact on converter performance and reliability. ٧. Awareness of Practical Considerations: Students should be aware of practical considerations and challenges associated with DC power converter implementation, such as thermal management, electromagnetic interference (EMI), component stress, and protection mechanisms. They should understand techniques to mitigate these issues. ٨. Ability to Evaluate Efficiency and Power Quality: Students should be able to assess the efficiency and power quality aspects of DC power converters, including efficiency calculations, harmonic content analysis, power factor correction, and mitigation of switching losses. ٩. Integration of DC Power Converters in Systems: Students should understand the integration of DC power converters in larger systems, such as renewable energy systems, electric vehicles, and power electronic interfaces. They should be aware of the interaction between converters and other system components. ١٠. Troubleshooting and Problem-Solving Skills: Students should develop troubleshooting and problem-solving skills to diagnose and rectify issues related to DC power converters. They should be able to analyze and interpret experimental data, identify sources of errors or failures, and propose solutions. These learning outcomes provide a comprehensive understanding of DC power converters, enabling students to design, analyze, and implement efficient and reliable power conversion systems.
Indicative Contents المحتويات الإرشادية	١. Introduction to Power Electronics Basic concepts and applications of power electronics Overview of DC power converters and their significance ٢. DC Power Converter Topologies Buck converter: operation, analysis, and control

	Boost converter: operation, analysis, and control Buck-boost converter: operation, analysis, and control Flyback converter: operation, analysis, and control Other DC-DC converter topologies (e.g., Cuk, SEPIC)
	٣. Power Semiconductor Devices
	Characteristics and selection criteria of diodes, MOSFETs, IGBTs, and other power devices Switching characteristics and losses of power devices Thermal considerations and heat sinks
	٤. Passive Components and Magnetics
	Characteristics and selection criteria of inductors and capacitors Design and modeling of magnetic components (e.g., transformers, inductors) Core materials and magnetic losses
	٥. Control Techniques for DC Power Converters
	Pulse width modulation (PWM) techniques and their implementation Voltage mode control and current mode control Hysteresis control and sliding mode control Stability analysis and design considerations
	٦. Modeling and Simulation of DC Power Converters
	Mathematical modeling of DC power converters Simulation tools and software (e.g., MATLAB/Simulink, PSpice) Transient and steady-state analysis Parameter variation and sensitivity analysis Control Loop Design and Stability Compensation techniques for control loops Bode plots and frequency response analysis Stability criteria (e.g., Nyquist criterion, root locus analysis) Design of feedback and feedforward control loops
	٧. Power Quality and Efficiency Considerations
	Efficiency calculations and optimization techniques Harmonic content analysis and mitigation techniques Power factor correction (PFC) techniques Mitigation of switching losses and EMI
	٨. Practical Considerations and Implementation
	Thermal management and heat sinks Component stress and reliability considerations Protection mechanisms (e.g., overcurrent, overvoltage, short-circuit) Snubber circuits and soft-switching techniques
	٩. Applications of DC Power Converters
	Renewable energy systems (e.g., solar, wind) Electric vehicle power electronics Power electronic interfaces (e.g., AC-DC converters, DC-AC inverters) Industrial power supplies and consumer electronics
	١٠. Case Studies and Practical Projects
	Analysis and design of specific DC power converter applications

	Hardware implementation and experimental validation Troubleshooting and problem-solving exercises These indicative contents cover the key topics and concepts typically included in a DC power converter course. They provide a foundation for understanding, analyzing, and designing various DC power [16 hrs]

Learning and Teaching Strategies استراتيجيات التعلم والتعليم	
Strategies	١. Lectures: Traditional lectures can be used to introduce the theoretical concepts and principles of DC power converters. Instructors can present the material using visual aids, such as slides or whiteboards, and explain the underlying theory, operating principles, and design considerations. ٢. Hands-on Laboratory Sessions: Practical laboratory sessions are essential for students to gain hands-on experience with DC power converters. These sessions can involve building and testing actual converters, measuring performance parameters, and troubleshooting. Students can also use simulation software or hardware-in-the-loop setups to simulate and analyze converter behavior. ٣. Design Projects: Assigning design projects related to DC power converters allows students to apply their knowledge and skills to real-world scenarios. They can be given specific requirements and constraints to design, simulate, and build a power converter for a given application. This promotes problem-solving skills, critical thinking, and practical application of concepts. ٤. Case Studies and Examples: Presenting case studies and practical examples of DC power converter applications can help students understand the relevance and significance of the concepts learned. Analyzing and discussing real-world implementations, challenges faced, and solutions adopted can enhance their problem-solving abilities and broaden their perspective. ٥. Group Discussions and Peer Learning: Encouraging group discussions and peer learning activities allows students to exchange ideas, discuss concepts, and learn from each other's experiences. This can be done through group projects, problem-solving sessions, or collaborative analysis of research papers and industry reports related to DC power converters. ٦. Online Resources and Simulations: Utilizing online resources, such as video tutorials, interactive simulations, and online modules, can enhance learning accessibility and provide additional reinforcement of concepts. Virtual simulations and interactive tools can help students visualize and manipulate DC power converter circuits, observe their behavior, and gain practical insights. ٧. Guest Lectures and Industry Collaboration: Inviting guest lecturers from industry or research organizations can expose students to real-world applications, emerging trends, and practical challenges in the field of DC

power converters. Industry collaborations can provide opportunities for internships, projects, and exposure to the latest advancements and technologies.

٨. Assessments and Feedback: Regular assessments, such as quizzes, exams, and assignments, can evaluate students' understanding of the concepts and their ability to apply them. Constructive feedback should be provided to help students identify areas of improvement and reinforce their learning.

٩. Self-Study and Research: Encouraging self-study and research allows students to explore specific topics of interest related to DC power converters. They can delve deeper into advanced concepts, explore recent research papers, and broaden their knowledge base beyond the curriculum.

١٠. Continuous Learning and Professional Development: Promoting continuous learning and professional development opportunities, such as workshops, seminars, and industry conferences, can help students stay updated with the latest developments and trends in DC power converters. It encourages lifelong learning and prepares them for future challenges and advancements in the field.

By combining a variety of teaching strategies, educators can create an engaging and comprehensive learning experience for students studying DC power converters. It allows them to develop a strong theoretical foundation, practical skills, problem-solving abilities, and critical thinking skills necessary for success in this field.

Student Workload (SWL)
الحمل الدراسي للطالب

Structured SWL (h/sem) الحمل الدراسي المنتظم للطالب خلال الفصل	63	**Structured SWL (h/w)** الحمل الدراسي المنتظم للطالب أسبوعيا	4.2
Unstructured SWL (h/sem) الحمل الدراسي غير المنتظم للطالب خلال الفصل	62	**Unstructured SWL (h/w)** الحمل الدراسي غير المنتظم للطالب أسبوعيا	4.1
Total SWL (h/sem) الحمل الدراسي الكلي للطالب خلال الفصل	125		

Module Evaluation
تقييم المادة الدراسية

		Time/Number	Weight (Marks)	Week Due	Relevant Learning Outcome
Formative assessment	**Quizzes**	6	10% (10)	3, 5,7,10	LO , 2, 5,7,9,10 and 11
	Assignments	9	10% (10)	2- 12	LO # 3, 4, 6 and 10
	Projects / Lab.	7	10% (10)	Continuous	All
	Report	8	10% (10)	2,4,6,8,10,12	LO # 5, 8 and 10
Summative assessment	**Midterm Exam**	1 hr	10% (10)	8	LO # 1-8
	Final Exam	3 hr	50% (50)	15	All
Total assessment			100% (100 Marks)		

Delivery Plan (Weekly Syllabus)
المنهاج الاسبوعي النظري

	Material Covered
	Week ١:
	• Introduction to DC power conversion principles • Types and applications of DC power converters • Overview of converter topologies
	Week ٢:
	* DC-DC Buck Converters:
	• Operating principle and steady-state analysis • Control techniques: voltage mode and current mode control • Design considerations and component selection
	Week ٣:
	* DC-DC Boost Converters:
	• Operating principle and steady-state analysis • Control techniques: voltage mode and current mode control • Design considerations and component selection
	Week ٤ and ٥:
	* Buck-Boost Converters:
	• Operating principle and steady-state analysis • Control techniques: voltage mode and current mode control • Design considerations and component selection

Week ٦:

* Flyback Converters:

- Operating principle and steady-state analysis
- Control techniques: voltage mode and current mode control
- Design considerations and component selection

Week ٧, ٨, and ٩:

* Other DC Power Converter Topologies:

- Cuk converters
- SEPIC converters
- Zeta converters
- Full-bridge converters
- Half-bridge converters

Week ١٠ and ١١:

* Control Techniques for DC Power Converters:

- Pulse width modulation (PWM)
- Voltage mode control
- Current mode control
- Hysteresis control
- Feedback and compensation techniques

Week ١٢ and ١٣:

* Modeling and Simulation of DC Power Converters:

- Small-signal modeling and transfer functions
- Large-signal and time-domain simulation
- Transient response analysis

Week ١٤:

* Efficiency and Power Quality Analysis:

- Efficiency calculations and optimization techniques
- Harmonic content analysis and mitigation strategies
- Power factor correction techniques
- Switching losses and soft-switching techniques

	Week ١٥:
	* Final Exam:

Delivery Plan (Weekly Lab. Syllabus) المنهاج الاسبوعي للمختبر	
	Material Covered
Week 1	Lab 1: • Lab Safety and Introduction to Lab Equipment • Familiarization with Power Supplies, Oscilloscopes, and Multimeters • Introduction to Breadboarding and Circuit Building Techniques
Week 2	Lab 2: Building and Testing a Buck Converter: Design and build a buck converter circuit
Week 3	Lab 3: Building and Testing a Boost Converter: Design and build a buck converter circuit
Week 4	Lab 4: Building and Testing a Buck-Boost Converter: Design and build a buck converter circuit
Week 5	Lab 5: Building and Testing a Flyback Converter: Design and build a buck converter circuit
Week 6	Lab 6: Simulation of DC Power Converters using simulation software (e.g., MATLAB/Simulink)
Week 7, 8	Lab 7 and 8: simulate various DC power converter topologies
Week 9	Lab 9: Analyze and compare their performance characteristics (e.g., efficiency, voltage/current waveforms)
Week 10	Lab 10: DC-DC ONE- Quadrant
Week 11	Lab 11: DC-DC two- Quadrant
Week 12	Lab 12: DC-DC Four- Quadrant
Week 13	Lab 13: DC-DC ONE- Quadrant with DC Motor as a load
Week 14	Review

Learning and Teaching Resources مصادر التعلم والتدريس		
	Text	**Available in the Library?**
Required Texts	**Mohummed Rashid" Power electronics circuits, Devices and application" ٤th edition, ٢٠١٤.**	Yes
Recommended Texts		No
Websites		

APPENDIX:

GRADING SCHEME مخطط الدرجات				
Group	**Grade**	التقدير	**Marks (%)**	**Definition**
Success Group	**A** - Excellent	امتياز	٩٠ - ١٠٠	Outstanding Performance

(٥٠ - ١٠٠)	**B** - Very Good	جيد جدا	٨٠ - ٨٩	Above average with some errors
	C - Good	جيد	٧٠ - ٧٩	Sound work with notable errors
	D - Satisfactory	متوسط	٦٠ - ٦٩	Fair but with major shortcomings
	E - Sufficient	مقبول	٥٠ - ٥٩	Work meets minimum criteria
Fail Group (٠ – ٤٩)	**FX** – Fail	مقبول بقرار	(٤٥-٤٩)	More work required but credit awarded
	F – Fail	راسب	(٠-٤٤)	Considerable amount of work required

Note:

NB Decimal places above or below ٠,٥ will be rounded to the higher or lower full mark (for example a mark of ٥٤,٥ will be rounded to ٥٥, whereas a mark of ٥٤,٤ will be rounded to ٥٤. The University has a policy NOT to condone "near-pass fails" so the only adjustment to marks awarded by the original marker(s) will be the automatic rounding outlined above.