Form: Course Syllabus		
	Form Number	EXC-01-02-02A
	Issue Number and Date	2/3/24/2022/2963 05/12/2022
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	Number of Pages	06

1.	**Course Title**	Introductory Accelerator Physics
2.	**Course Number**	0332965
3.	**Credit Hours (Theory, Practical)**	3
	Contact Hours (Theory, Practical)	
4.	**Prerequisites/ Corequisites**	
5.	**Program Title**	
6.	**Program Code**	
7.	**School/ Center**	
8.	**Department**	
9.	**Course Level**	
10.	**Year of Study and Semester (s)**	
11.	**Other Department(s) Involved in Teaching the Course**	
12.	**Main Learning Language**	
13.	**Learning Types**	☒Face to face learning ☐Blended ☐Fully online
14.	**Online Platforms(s)**	☐Moodle ☐Microsoft Teams
15.	**Issuing Date**	
16.	**Revision Date**	

17. Course Coordinator:

Name:	Contact hours:
Office number:	Phone number: 22023
Email:	

18. Other Instructors:

Name:

Office number:

Phone number:

Email:

Contact hours:

Name:

Office number:

Phone number:

Email:

Contact hours:

19. Course Description:

As stated in the approved study plan.

20. Program Intended Learning Outcomes: (To be used in designing the matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program)

1. **SO1:** to be able to demonstrate an advanced and comprehensive understanding of core physics concepts and specialized knowledge in a chosen field of research, contributing to the frontier of physics.
2. **SO2:** to be able to develop and execute independent, original research projects that address complex scientific problems, advancing theoretical and experimental physics.
3. **SO3:** to be able to apply advanced mathematical and computational techniques to analyze complex physical phenomena and critically evaluate scientific literature and experimental results.
4. **SO4:** to be able to effectively communicate complex physics concepts, research findings, and their significance through academic writing, presentations, and public outreach.
5. **SO5:** to be able to adhere to high ethical standards and professional responsibility in conducting research, including data integrity, ethical treatment of subjects, and the responsible use of resources.
6. **SO6:** to be able to demonstrate leadership and collaborative skills within multidisciplinary teams, contributing to the development of new scientific knowledge and promoting knowledge-sharing across disciplines.
7. **SO7:** to be able to cultivate the ability to adapt to new scientific advancements and continuously engage in professional development to contribute to innovation in the field of physics.

SO8: to be able to master experimental and computational techniques relevant to the research field, demonstrating competency in operating and developing specialized physics instrumentation and software.

21. Course Intended Learning Outcomes: (Upon completion of the course, the student will be able to achieve the following intended learning outcomes)

1. Introduction to Accelerator Physics
2. Basic Concepts in Particle Motion
3. Electric and Magnetic Fields in Accelerators
4. Beam Dynamics Basics
5. Accelerator Components
6. Particle Acceleration Mechanisms
7. Basic Beam Transport and Lattice Design
8. Beam Diagnostics and Measurement
9. Introduction to Computational Tools
10. Safety in Accelerator Facilities
11. Current Challenges and Future Trends
12. Emerging technologies

Course ILOs	The learning levels to be achieved					
	Remembering	**Understanding**	**Applying**	**Analysing**	**evaluating**	**Creating**
1		✓	✓	✓		
2		✓	✓	✓		
3		✓	✓	✓		
4		✓	✓	✓		
5						
6						
7						
8						
9						
10		✓	✓	✓		
11		✓	✓	✓		
12		✓	✓	✓		

2٢. The matrix linking the intended learning outcomes of the course with the intended learning outcomes of the program:

Program ILOs / Course ILOs	ILO (1)	ILO (2)	ILO (3)	ILO (4)	ILO (5)
1	✓				
2	✓				
3	✓				
4	✓				
5	✓				
6	✓				
7	✓				
8	✓				
9	✓				
	✓				
11	✓				
12	✓				

2٣. Topic Outline and Schedule:

Week	Lecture	Topic	ILO/s Linked to the Topic	Learning Types	Platform Used	Synchronous / Asynchronous	Evaluation Methods	Learning Resources
1	1.1	**Introduction to Accelerator Physics**: Overview of accelerator physics and its significance, History and evolution of particle accelerators						
	1.2	Types of accelerators: linear accelerators (linacs), cyclotrons, synchrotrons, storage rings						
	1.3	Applications in fundamental research, medical physics, and industry						

2	2.1	**Basic Concepts in Particle Motion:** Kinematics and dynamics of charged particles, Relativistic and non-relativistic motion						
	2.2	Lorentz force and the role of electromagnetic fields						
	2.3	Particle velocity, momentum, and energy in accelerators						
3	3.1	**Electric and Magnetic Fields in Accelerators**: Electrostatic fields and their use in particle acceleration						
	3.2	Magnetic fields: role of dipoles, quadrupoles, and sextupoles in steering and focusing						
	3.3	Principles of electromagnetic waves (RF) used in acceleration						
4	4.1	Field configurations in common accelerator components (cavities, magnets)						
	4.2	**Beam Dynamics Basics:** Concept of phase space, beam emittance, and beam envelope						
	4.3	Transverse and longitudinal beam dynamics						
5	5.1	Basic motion of a particle beam: betatron motion, synchrotron motion						
	5.2	Longitudinal bunch motion and RF phase locking						
	5.3							
6	6.1	**Accelerator Components:** Radiofrequency (RF) cavities and their role in accelerating particles						
	6.2	Magnetic elements: bending magnets, quadrupoles, and higher-order magnets						
	6.3	Vacuum systems and the importance of maintaining beam quality						
7	7.1	Beamline elements and their design considerations						
	7.2	**Particle Acceleration Mechanisms:** Principles of acceleration in DC, RF, and time-varying electric fields						
	7.3	Basics of resonant acceleration in RF cavities						
8	8.1	Comparison between different acceleration methods (e.g., linear, cyclic, and plasma-based)						
	8.2	**Basic Beam Transport and Lattice Design:** Transport of charged particles through magnetic fields						
	8.3	Lattice design principles: focusing, bending, and quadrupole triplets						
9	9.1	Simple beamline design and optimization for transport						
	9.2	**Beam Diagnostics and Measurement:** Beam position monitors, current transformers, and profile monitors						
	9.3	Measurement of beam intensity, size, and emittance						
10	10.1	Basic diagnostic tools for beam tuning and characterization						
	10.2	**Introduction to Computational Tools:** Basics of numerical simulations in accelerator physics						
	10.3	Overview of common software tools for beam dynamics simulation (e.g., MAD-X,…)						
11	11.1	**Introduction to particle tracking algorithms and methods**						
	11.2	Applications of Accelerators: Accelerators in high-energy physics: colliders and detector						
	11.3	Medical applications: particle therapy (e.g., proton therapy)						
12	12.1	Industrial applications: ion implantation, material testing, and radiation processing						

	12.2	**Safety in Accelerator Facilities**: Radiation safety protocols							
	12.3	Shielding and beam containment							
13	13.1	Operational and safety standards for accelerator operation							
	13.2	**Current Challenges and Future Trends:**							
	13.3	Limitations in accelerator performance and beam quality							
14	14.1	**Emerging technologies:** plasma wakefield accelerators, superconducting RF							
	14.2	The future of compact accelerators and their potential applications:							
	14.3	Proton synchrotron, Spallation Neutron Source, Collider, Luminosity, Wakefield, electron plasma wave, electron density perturbation, plasma oscillation, accelerating gradient							
15	15.1	Obtaining Twiss parameters and invariant of motion, periodic optics and Twiss parameters. Concept of beam emittance, RMS emittance and normalized emittance, FODO optics and concept of stability,. Introduction to dispersion and achromat							
	15.2								
	15.3								

2٤. Evaluation Methods:

Opportunities to demonstrate achievement of the ILOs are provided through the following assessment methods and requirements:

Evaluation Activity	Mark	Topic(s)	ILO/s Linked to the Evaluation activity	Period (Week)	Platform
First Exam	30		1-4	6	On campus
Second Exam	30		5-8	11	On campus
Final Exam	40		1-12	15	On campus

2٥. Course Requirements:

(e.g.: students should have a computer, internet connection, webcam, account on a specific software/platform…etc.):

2٦. Course Policies:

A- Attendance policies:

B- Absences from exams and submitting assignments on time:

C- Health and safety procedures:

D- Honesty policy regarding cheating, plagiarism, misbehavior:

E- Grading policy:

F- Available university services that support achievement in the course:

2٧. References:

A- Required book(s), assigned reading and audio-visuals:

- Accelerator Physics, by S. Y. Lee

B- Recommended books, materials, and media:

- An Introduction to the Physics of High Energy Accelerators, by D. A. Edwards and M. J. Syphers
- *Introduction To The Physics Of Particle Accelerators*, by Mario Conte and William W Mackay
- *Particle Accelerator Physics*, by Helmut Wiedemann
- *The Physics of Particle Accelerators: An Introduction*, by Klaus Wille and Jason McFall

2٨. Additional information:

Name of the Instructor or the Course Coordinator: …………………………………………………	Signature: ………….………………	Date: …….…………
Name of the Head of Quality Assurance Committee/ Department …………………………………………………	Signature: ………….………………	Date: …….…………
Name of the Head of Department …………………………………………………	Signature: ………….………………	Date: …….…………
Name of the Head of Quality Assurance Committee/ School or Center …………………………………………………	Signature: ………….………………	Date: …….…………
Name of the Dean or the Director …………………………………………………	Signature: ………….………………	Date: …….…………