Lahore University of Management Sciences

SCI 202: Stars & Galaxies

Summer-II 2021

Instructor	Dr. Shaukat Goderya
Room No.	
Office Hours	TBA
Email	
Telephone	
Teaching Assistants (TAs)	TBA
TA Office Hours	TBA
Course URL (if any)	LMS

Course Teaching Methodology
• Teaching methodology: This course is only offered in synchronous and asynchronous mode of teaching. • Lecture details: Lectures will be delivered live using power point presentations and/or active digital writing via zoom. Recording will be made available on LUMS LMS.

COURSE BASICS				
Credit Hours	3			
Lectures (s)	20	110 min each		
Lab	None			
Recitation/Lab (per week)				
Tutorial (per week)				

COURSE DISTRIBUTION	
Core	
Elective	SBASSE Elective, Free Elective
Open for Student Category	Open for All
Closed for Student Category	

COURSE DESCRIPTION
The subject of Astronomy and Astrophysics has seen tremendous breakthrough in the last decade or so, first the launch of the Hubble space telescope in 1995 and the spectacular discoveries it has made, then the discovery of the first extrasolar planet around a main sequence star 51 Pegasi and just a few years ago the detection of gravitation waves around supermassive binary black holes and first ever real image produced of a black hole as revolutionized our understanding the Universe. The long-awaited launch of the James Webb telescope will increase our horizon in astronomy multifold in comparison to the above listed discoveries. There is great excitement not only in the western nations but even for astronomers is developing and third world counties. The goal of this course is to bring this excitement to undergraduate students and who want an understanding of the fundamental topics in Astronomy, Stellar Astrophysics, Galactic Astronomy and Cosmology and who intend to pursue advance degrees in graduate school and/or interested in STEM related careers. The course is designed for undergraduate students who have had Calculus 1 and some calculus-based courses in mechanics, electricity, magnetism and optics. that is often required of students wanting to pursue graduate school or careers in space and aeronautical science related fields.

COURSE PREREQUISITE(S)	
	• Calculus I at LUMS (Math 101) or • Either Math 102 or PHY 101 or PHY 102

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	• calculus-based physics and mathematics orientation at the levels of FSc/A-Level

COURSE OBJECTIVES
• Develop basic skills and knowledge that is needed to pursue careers in space science and related STEM fields. • Understand how Astronomers use modern research tools and techniques to study celestial objects and gather and analyses astronomical data. • Understand how astronomy is interwoven with other disciplines like Physics, Mathematics, Computer Science, Chemistry etc. • Understand what is our place in the universe and how do humans fit in the time scale of the universe. • Understand why we should study astronomy.

LEARNING OUTCOMES
At the end of this course, students should be able to: • Describe the tools astronomers use to chart and record the position and motion of celestial bodies. • Explain the various phenomenon that humans observe on Earth due to motion around the Sun. • Explain how astronomers record and analyze light coming from celestial bodies. • Describe the Life cycle of stars. • Explain the big bang model of the universe.

GRADING POLICY		
Assignments	15 %	3-4 assignments
Attendance and class participation	15 %	
Project	10%	Project – Assigned at the end of Second Week.
Midterm	30 %	
Final Exam	30 %	

EXAMINATION DETAIL	
Midterm Exam	Yes
Final Exam	Yes

Harassment Policy
Harassment of any kind is unacceptable, whether it be sexual harassment, online harassment, bullying, coercion, stalking, verbal or physical abuse of any kind. Harassment is a very broad term; it includes both direct and indirect behaviour, it may be physical or psychological in nature, it may be perpetrated online or offline, on campus and off campus. It may be one offense, or it may comprise of several incidents which together amount to sexual harassment. It may include overt requests for sexual favours but can also constitute verbal or written communication of a loaded nature. Further details of what may constitute harassment may be found in the LUMS Sexual Harassment Policy, which is available as part of the university code of conduct. LUMS has a Sexual Harassment Policy and a Sexual Harassment Inquiry Committee (SHIC). Any member of the LUMS community can file a formal or informal complaint with the SHIC. If you are unsure about the process of filing a complaint, wish to discuss your options or have any questions, concerns, or complaints, please write to the Office of Accessibility and Inclusion (OAI, oai@lums.edu.pk) and SHIC (shic@lums.edu.pk) —both of them exist to help and support you and they will do their best to assist you in whatever way they can. **To file a complaint, please write to** harassment@lums.edu.pk.
SSE Council of Equity and Belonging
In addition to LUMS resources, SSE's **Council on Belonging and Equity** is committed to devising ways to provide a safe, inclusive and respectful learning environment for students, faculty and staff. To seek counsel related to any issues, please feel free to approach either a member of the council or email at cbe.sse@lums.edu.pk

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COURSE OVERVIEW			
Lec.	Topics	Recommended Readings	Objectives/ Guidepost
	Topic 1: Fundamental Astronomy		
1-5	1. The Celestial Sphere a. The day and night sky b. Greek astronomy c. Positions and coordinates of stars d. Motion of Earth and Moon 2. Celestial Mechanics a. Geometry of Ellipse b. Kepler's Laws - Qualitative c. Newtonian Mechanics d. Kepler's Laws - Quantitative	Lecture notes	– Learn some basic definitions and terminologies used in astronomy. – Learn about the Heliocentric and Geocentric models of the solar system and explain stellar parallax. – Learn what causes season, eclipses and lunar phases. – Be able to describe season, eclipses, and lunar phases and stellar – Understand the spherical triangle and learn how the positions of stars are determined and computed in different coordinate systems. – Understand and be able to described Kepler's laws, Newton's laws. – Be able to derive various physical quantities related to motion of stars and planets.
	Topic 2: Electromagnetic Radiation and Matter		
6-9	1) Quantifying Brightness of Stars a) The magnitude system b) The electromagnetic waves c) Blackbody radiation d) Brightness and Luminosity e) Color Index 2) Light from Atoms a) Bohr model of atom b) Spectroscopes and Spectroscopy 3) Telescopes a) Basic Optics b) Reflectors and Refractors and Design Parameters c) Telescope Mounting d) Light Detectors	lecture notes	– Be able to describe how light is quantified and calculate the distances of stars from its magnitude. – Be able to describe and work with blackbody radiation laws – Understand how light is produces in atoms, and why stars are considered black bodies. – Learn how light from atoms is analyzed. – Be able to describe the function of a spectroscope and the various kinds of spectra we observe. – Understand how optical and radio telescope function and why we need them. – Learn how is light captured by the telescope and digitized for storage and analysis. – Be able to explain why must some telescope go into space.
10	**Midterm Examination**		
	Topic 3: The Physics of Stars I		
11-15	1) Stellar Parameters a) Basic parameters b) Binary Stars c) Spectra of Stars d) Hertzsprung-Russel Diagram 2) Stellar Structure a) Stellar Atmospheres b) Stellar Interiors c) The Sun 3) Star Birth a) Interstellar Medium b) Protostars c) Pre-Main-Sequence Evolution 4) Stellar Evolution a) Evolution on the Main-Sequence b) Evolution of Low Mass stars c) Evolution of high mass stars d) Star Clusters e) Pulsating stars 5) Stellar Death		– Be able to determine how afar are stars – Be able to determine how much energy do star make. – Be able to determine how big are stars. – Be able to determine how much mass do stars contain. – Learn what is interstellar medium and what material it is made up of. – Learn how astronomers study gas and dust between stars. – Learn how matter between stars interact with stars. – Learn how do stars form, maintain their structure and stability. – Learn what evidence do we have that theories of star formation is correct. – Learn what energy mechanisms occur in stellar interiors. – Learn how do we build models of stars. – Learn the relationship between mass and luminosity of a main-sequence stars. – Learn how does a star change when it evolves. – Learn what evidence do astronomers have that stars really evolve. – Learn how our Sun will die. – Learn why there are so many white dwarf stellar remnants. – Learn How do massive stars die. – Learn whys does theory predict the existence of neutrons stars and

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	a) Chandrasekhar limit b) White Dwarfs c) Supernovae d) Neutron Stars e) Pulsars f) Black Holes		black holes. – Learn why are sure that neutron stars and black holes exist.
Topic 4: The Universe			
16-19	1) Milky Way a) Shape and Basics Properties b) Stellar Motions and Galactic Rotation c) The Evolution of Our Galaxy 2) Galaxies Beyond the Milky Way a) The Hubble Sequence b) Hubble's Law and Distance Scale c) Interaction of Galaxies and Evolution d) Cluster and Supercluster 3) Active Galaxies and Quasars a) AGN's b) Quasars c) Supermassive Black Holes 4) Cosmology a) The Age of the Universe b) A Model of the Universe c) The Beginning of the Universe d) The Cosmic Microwave Background e) The Inflationary Universe f) Anthropic Principle	lecture notes	– Learn how do we know that we live in a galaxy. – Learn how do we know what is the shape of our galaxy and how did it form and evolve. – Learn what different types of galaxies do we observer and how do they differ in size, luminosity and mass. – Be able to determine distance to other galaxies. – Learn why there are different kinds of galaxies. – Learn why our galaxy has supermassive black hole. – Learn what makes some galaxies core active. – Be able to explain AGN's and Quasars. – Understand what are supermassive black holes, how do they form, evolve and erupt. – Explore whether the Universe has an edge or a center. – Learn how we know that the Universe began with a big bang. – Learn how has the Universe evolved and what will be its fate.
20	**Final Examination**		

Textbook(s)/Supplementary Readings

These are the suggested textbooks for the course. However, there are many resources that can be found on the internet and in the public domain as alternatives to these texts. The material and lecture notes provided by me should be sufficient in most cases.

An Introduction to Modern Astrophysics
Bradley W. Carroll, Dale A. Ostlie
SBN-13: 978-0805304022
ISBN-10: 0805304029

Foundations of Astrophysics
Barbara Ryden
ISBN-13: 978-1108831956
ISBN-10: 1108831958

For Freshman level Introduction to Astronomy:
This is a lower-level astronomy text and severs to fill the prerequisite and review.
https://openstax.org/books/astronomy/pages/1-introduction