SEMESTER LEARNING ACTIVITY PLANS
(SLAP)
SEMESTER ODD 2022/2023

Astrophysics

MFF5951 / 3 Credits

Lecturer Coordinator:

Dr. Arief Hermanto, Drs., S.U., M.Sc.

UNIVERSITAS GADJAH MADA
FACULTY OF MATHEMATICS AND NATURAL SCIENCE
2022

Universitas Gadjah Mada
Faculty of Mathematics and Natural Science
Physics Department / Study Program Master Physics
Semester Odd 2022/2023

SEMESTER LEARNING ACTIVITY PLANS (SLAP)

Code	Course Name	Credits (credits)	Semester	Status	Prerequisite
MFF5951	*Astrophysics*	*3*	*Odd*	*Elective*	*None*

Short Description

Astrophysics course is Elective course 3 credits (Theory) in the 2022 Curriculum Master Physics Study Program, Faculty of Mathematics and Natural Science UGM.

The syllabus of this course is as follows:
1. Structure, properties of stars, and their radiation spectrum (luminosity, H.R. diagram), star population (mass and age), distance and magnitude, impermeability, and radiative forcing. Mechanical equilibrium in stars: equations of momentum and continuity, potential energy, virial theorem for stars.
2. Mechanical equilibrium in a rotating star: equilibrium configuration, stellar structural equations for shell rotation.
3. Energy balance in stars: radiation transfer, energy balance, the rate of energy generation from gravitational collapse, temperature and density changes for adiabatic contraction, secular stability of nuclear combustion, and the role of radiation pressure in stars.
4. Energy conservation and radiative equilibrium in a rotating star: radiative equilibrium in a rotating star, radiation transfer for a rotating star, interactions between rotation and radiation effects, threshold rotational velocity.
5. Convection in stars, gravitational waves in stars, Mixing-Length theory for convective flow, convection in the interior of stars, Non-adiabatic convection, and convection in the brightest stars.
6. Galaxy: classification of galaxies, elliptical galaxies, disk galaxies, spiral galaxies, Milky Way, galaxies dwarfs, active galactic nuclei, galaxy population statistical properties.
7. Galaxy Structure: distribution of stars, chemical composition and age, gas and dust in the galaxy, cosmic rays, distance to the center of the galaxy, the location of the center of the galaxy, central star clusters.
8. Galactic Kinematics: determination of star velocity, rotation curve of a galaxy.

The courses are held in class for 14 weeks, each week's session last for 3 x 50 minutes. Four weeks of course period is used for Midterm Exam and Final Exam, each held for two weeks as scheduled.

Student evaluation for course assessments is performed summative and formative. The summative evaluation is implemented as written exams, both Midterm and Final Exam, which take a maximum of 120 minutes. The formative evaluation is implemented as individual assignments for each student in the form of completing an assignment individually. Monitoring is carried out by observing student activities during the course, such as attendance, Q&A and discussion about the material presented, and student performance in completing individual assignments.

Program Learning Outcomes (PLO) Imposed on the Course

PLO 3	Mastering further knowledge of classical and modern physics theory, and its relationship with other disciplines, and has mastered an advanced field of physics specialization that allows him to keep up with the latest international research developments.
PLO 4	Mastering various mathematical disciplines related to an advanced field of physics, and able to develop physical models using various mathematical and computational tools with an inter or multidisciplinary approach to solving problems related to an advanced field of physics.

	PLO 6	Able to apply knowledge to analyze, synthesize, formulate problems and solve problems comprehensively in one of advanced field of physics, through experimental or theoretical research, then be able to classify and draw conclusions about their findings for the development of science and technology.

Course Outcomes (CO)	**Upon completion of this course, students should be able to:**	
	CO1	Understand the structure, properties of stars, and their radiation spectrum (luminosity, H.R. diagram), star population (mass and age), distance and magnitude, impermeability and radiative forcing, mechanical equilibrium in stars (equations of momentum and continuity, potential energy, virial theorem for stars).
	CO2	Understand the mechanical equilibrium in a rotating star (equilibrium configuration, stellar structural equations for skin rotation), energy balance in stars (radiation transfer, energy balance), the rate of energy generation from gravitational collapse, and temperature and density changes for adiabatic contraction.
	CO3	Understand the secular stability of nuclear combustion, the role of radiation pressure in stars, Energy conservation and radiative equilibrium for a rotating star, the radiative equilibrium for a rotating star, radiation transfer for a rotating star, interactions between rotation and radiation effects, and threshold rotational velocity.
	CO4	Understand Convection in stars, gravitational waves in stars, Mixing-Length theory for convective flow, convection in the interior of stars, Non-adiabatic convection, convection in the brightest stars, Galaxy classification of galaxies, elliptical galaxies, disk galaxies, spiral galaxies, Milky Way, galaxies dwarfs, active galactic nuclei, galaxy population statistical properties.
	CO5	Understand the structure of the Galaxy, distribution of stars, chemical composition and age, gas and dust in the galaxy, cosmic rays, distance to the center of the galaxy, the location of the center of the galaxy, central star clusters, Galactic Kinematics, determination of star velocity, rotation curve of a galaxy.
	CO6	
	CO7	
	CO8	

The Correlation of CO to Learning Materials and Methods, and Time Allocation		**Learning Materials**	**Learning Methods**	**Time Allocation**
	CO1	The structure, properties of stars and their radiation spectrum: luminosity, HR diagram.	Lecture	3 x 50 minutes
	CO1	Star population (mass and age), distance and magnitude, density and radiative force.	Lecture	3 x 50 minutes
	CO1	Mechanical equilibrium in stars: momentum and continuity equations, potential energy, virial theorem for stars.	Lecture	3 x 50 minutes
	CO2	Mechanical equilibrium in a rotating star: equilibrium	Lecture	3 x 50 minutes

		configuration, stellar structural equations for shellular rotation.		
	CO2	Energy balance in stars: radiative displacement, energy balance.	Lecture	3 x 50 minutes
	CO2	The rate of energy generation from gravitational collapse, temperature and density changes for adiabatic contraction.	Lecture	3 x 50 minutes
	CO2	Secular stability of nuclear combustion, the role of radiation pressure in stars.	Lecture	3 x 50 minutes
	CO3	Energy conservation and radiative equilibrium in a rotating star: radiative equilibrium in a rotating star.	Lecture	3 x 50 minutes
	CO3	Radiative displacement for a rotating star, interaction between rotation and radiation effects, threshold rotational speed.	Lecture	3 x 50 minutes
	CO3	Convection in stars: gravitational waves in stars, Mixing-Length theory for convective flow, convection in stellar interiors.	Lecture	3 x 50 minutes
	CO4	Nonadiabatic convection, convection in the brightest stars.	Lecture	3 x 50 minutes
	CO4	Galaxies: classification of galaxies, elliptical galaxies, disk galaxies, spiral galaxies, Milky Way, dwarf galaxies, active galactic nuclei, statistical properties of galaxy populations.	Lecture	3 x 50 minutes
	CO4	Galactic Structure: distribution of stars, chemical composition and age, gas and dust in the galaxy, cosmic rays, distance to the center of the galaxy, location of the center of the galaxy, central star clusters.	Lecture	3 x 50 minutes
	CO4	Galactic Kinematics: determination of the speed of stars, the rotation curve of a galaxy.	Lecture	3 x 50 minutes
	Final Exam/ Project Task Results/ Case Analysis Results			
Learning Methods	Lecture			
Student Learning Experience	Learn to analyze and review: The structure, properties of stars and their radiation spectrum: luminosity, HR diagram., Star population (mass and age), distance and magnitude, density and radiative force., Mechanical equilibrium in stars: momentum and continuity equations, potential energy, virial theorem for stars., Mechanical equilibrium in a rotating star: equilibrium configuration, stellar structural equations for shellular rotation., Energy balance in stars: radiative displacement, energy balance., The rate of energy generation from gravitational collapse, temperature and density changes for adiabatic contraction., Secular stability of nuclear combustion, the role of radiation pressure in stars., Energy conservation and			

<table>
<tr><td></td><td>radiative equilibrium in a rotating star: radiative equilibrium in a rotating star., Radiative displacement for a rotating star, interaction between rotation and radiation effects, threshold rotational speed., Convection in stars: gravitational waves in stars, Mixing-Length theory for convective flow, convection in stellar interiors., Nonadiabatic convection, convection in the brightest stars., Galaxies: classification of galaxies, elliptical galaxies, disk galaxies, spiral galaxies, Milky Way, dwarf galaxies, active galactic nuclei, statistical properties of galaxy populations., Galactic Structure: distribution of stars, chemical composition and age, gas and dust in the galaxy, cosmic rays, distance to the center of the galaxy, location of the center of the galaxy, central star clusters., Galactic Kinematics: determination of the speed of stars, the rotation curve of a galaxy..</td></tr>
<tr><td>Access to Learning Media/ LMS and Offline and Online Percentage</td><td>Sync (google meet), Asynchronous (google classroom, video)</td></tr>
<tr><td>Assessment Methods and Synchronization with CO</td><td>
<table>
<tr><th>Assessment Methods</th><th>Assessment Percentage</th><th>Criteria/Indicators</th><th>CO1</th><th>CO2</th><th>CO3</th><th>CO4</th></tr>
<tr><td>Participatory Activity*</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Project Results/ Case Study Results/ PBL Results*</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Cognitive</td></tr>
<tr><td>Assignment</td><td>30%</td><td></td><td>7,5%</td><td>7,5%</td><td>7,5%</td><td>7,5%</td></tr>
<tr><td>Quiz</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Midterm Exam</td><td>35%</td><td></td><td>17,5%</td><td>17,5%</td><td></td><td></td></tr>
<tr><td>Final Exam</td><td>35%</td><td></td><td></td><td></td><td>17,5%</td><td>17,5%</td></tr>
<tr><td colspan="7">*) can also be obtained from the Midterm or Final Exam as the result of participatory activities or project/ case study results. According to IKU 7, the percentage of project results/ case study/ PBL results is at least 50%.</td></tr>
</table>
</td></tr>
<tr><td>References</td><td>Main references:
1. Maeder A., 2009, Physics, Formation and Evolution of Rotating Stars, Springer-Verlag, Berlin.
2. Bradt H., 2008, Astrophysics Processes, Cambridge University Press, Cambridge.
3. Prialnik D., 2000, Introduction the theory of Stellar Structure and Evolution, Cambridge University Press, Cambridge.
4. Schneider P., 2006, Extragalactic Astronomy and Cosmology. An Introduction, SpringerVerlag, Berlin.
5. Sparke L.S., dan Gallagher III J.S., 2007, Galaxies in the Universe: An Introduction, 2nd Ed, Cambridge University Press.
6. Pradhan A.K. dan Nahar S.N., 2011, Atomic Astrophysics and Spectroscopy, Cambridge University Press, Cambridge.</td></tr>
<tr><td>Lecturers (Team Teaching)</td><td>1. Dr. Arief Hermanto, Drs., S.U., M.Sc.
2.
3.
4.</td></tr>
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Authorization	Date of Drafting	Lecturer Coordinator	Head of Curriculum Committee	Head of Study Program
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