# 13942 – 756 (8) Selected topics in theoretical physics (1.5L, 1.5P)

# 2021

## **Course summary:**

A selection of topics from: cosmology, general relativity, quantum mechanics, statistical physics, biological physics, or condensed matter physics.

Method of assessment: Flexible assessment

# Language policy:

English lectures and materials.

# Module relevance in programme:

In 2021 this module will cover general relativity and cosmology.

### **Outcomes of course:**

- Students will be exposed to general relativity, the modern, geometric theory of gravity and its application to cosmology and astrophysics.
- Aspects of differential geometry and the tensor formalism will be developed from first principles. The physical content of the theory will be emphasised.
- Students will be able to analyse physical systems exhibiting spacetime curvature. This has broad applications and will be important for any advanced study of classical and quantum field theories involving gravity.
- The skills acquired in this course are indispensable for the study of black holes, gravitational lenses and gravitational waves. These topics will be introduced here.
- Students will learn how to model the evolution of the matter and radiation content of the universe on large scales. The phenomenology of dark matter and dark energy will be introduced here.

### Lecturer:

**Dr A.J. John** Telephone number: +2721 8083371 E-mail address: <u>anslyn@sun.ac.za</u> Office: Room 1028, Merensky Physics Building.

### **Mentor:**

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for the Honours programme and its modules is Dr GW Bosman gwb@sun.ac.za.

# **Course content:**

- Lorentz transformations, the Minkowski spacetime, relativistic formulation of Maxwell's laws
- Riemannian geometry; tensor calculus, metrics, connections, covariant derivatives, curvature; geodesics
- General Relativity; the Einstein field equations, the Einstein-Hilbert action

- The Schwarzschild black hole; light and particle dynamics on curved spacetimes
- Introduction to Cosmology the composition and dynamics of the universe, dark matter and dark energy; Gravitational waves

### **Tutorials:**

One afternoon per week, as applicable under Covid-19 developments.

### **Study material:**

Lecture notes and other online resources will be uploaded on SUNLearn. Books will be placed on reserve at the Physics library.

### **Assessment:**

#### Methods of Assessment

Continuous Assessment, based on

- Series of assignments
- One tutorial test
- Final test

#### Venue and time of assessment opportunities

Test date set in honours calendar. One assignment every three weeks.

#### Availability of marks:

Turnaround time is typically one week. Feedback is given in terms of written and oral commentary as soon as possible.

Mark calculated: Assignments 50% + Tutorial test 10% + Final test 40%