תאריך עדכון: 13/06/2018

אוניברסיטת **בר-אילן**

יחסות כללית וקוסמולוגיה: 86-676-01

שם המרצה: פרופ' אסף פאר

סוג הקורס: הרצאה ותרגיל

שנת לימודים: תשע"ט **סמסטר:** ב' **היקף שעות:** 3 הרצאה 1 תרגיל

א. מטרת הקורס:

Familiarity with the mathematical and physical principles of general relativity and its applications, including black holes, gravitational waves, .and the basis of modern cosmology

ב. תוכן הקורס:

Week & Topic

1,2, 3/1 Introduction, special relativity, basics of vectors and tensors
3/2 - 4 The equivalence principle: gravity as geometry
5 Vectors and tensors in curved space-time
6, 7/1 Curvature
7/2 - 8/1 Einstein's field equation
8/2, 9 Schwarzschield solution: solar system tests of general relativity
10 Schwarzschield solution and black holes
11 (+extra lecture) Standard cosmology: the Friedmann-Robertson-Walker metric
12 Composition and history of the Universe:
Hubble's law, cosmological redshift, dark energy

ג. דרישות קדם:

Introduction to Modern Physics 86-170-01
Mechanics 86-115-01

ד. חובות הקורס:

Eight - ten homeworks will be given, usual rules apply.

ה. מרכיבי הציון הסופי:

80% final exam, 20% continuous assessment (homeworks).
Note: mid term exam possible.

It will account for 50% of the homework grade (10% of final grade).

ו. ביבליוגרפיה:

Books:

• S. Weinberg, Gravitation and Cosmology (Wiley, 1972). This is one of the main
textbooks of this course. A really good book at what it does, especially strong on astrophysics, cosmology, and experimental tests. However, it is very heavy in mathe-matics, and takes an unusual non-geometric approach to the material. Furthermore,it doesn't discuss black holes.

• J.B. Hartle, Gravity - an Introduction to Einstein's General Relativity (Addison-
Wesley, 2003). This is the second main textbook of this course. It is a very easy to read, and very straightforward, giving many updated examples. It focuses more on the physics, less on the mathematics, which implies some "hand-waving", and occasional need to return to the math. Giving very straightforward explanations, highly recommended for the confused student. It does cover all the material in the course,although not in order.

• S. Carroll, Spacetime and Geometry: An Introduction to General Relativity (Addison-
Wesley 2003). This is the third main textbook of this course. It is considered as a standard textbook in many places. It does an excellent job in balancing between the physics and the math. It goes mathematically somewhat deeper than we will have time to do. In addition to the textbook, Sean Carroll is kind enough to put his lectures notes freely available on the web. See http://preposterousuniverse.com/grnotes/ I find these notes to be very illuminating. Highly recommended.

• A.P. Lightman, W.H. Press, R.H. Price, & S.A. Teukolsky, Problem Book in

Relativity and Gravitation (Princeton, 1975). A sizeable collection of problems in all areas of GR, with fully worked solutions. I find it very helpful as an exercise book.

• B.F. Schutz, A First Course in General Relativity (Cambridge, 1985). This is a very nice introductory text. Especially useful if, for example, you aren't quite clear on what the energy-momentum tensor really means.

• C. Misner, K. Thorne and J. Wheeler (MTW), Gravitation (Freeman, 1973).
A heavy book, in various senses. Most things you want to know are in here, although you might have to work hard to get to them (perhaps learning something unexpected in the process).

• R. Wald, General Relativity (Chicago, 1984). Thorough discussions of a number of advanced topics, including black holes, global structure, and spinors. The approach is more mathematically demanding than the previous books, and the basics are covered pretty quickly.

• There are many additional textbooks on general relativity and cosmology. There are a few (unfortunately, not too many), in the library.

• Today, you can find many texts free on the web. Of course, the problem is that there is so much available, it is easy to get lost.

ז. שם הקורס באנגלית:

"Gravitation and Cosmology"