

KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 553 (HOMOLOGICAL ALGEBRA)
SPRING 2007 (SEM. 062)

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DESCRIPTION: Review of free, projective, and injective modules, direct limits. Watt's theorems. Flat modules. Localization. Noetherian, semisimple, Von Neumann regular, hereditary, and semi-hereditary rings. Homology, homology functors, derived functors. Ext. and Tor. homological dimensions, Hilbert syzygy theorem.

Prerequisite: MATH 551

TEXT BOOK: M. Osborne, *Basic Homological Algebra*, Springer (2000).
accompanied by: J. Rotman, *An Introduction to Homological Algebra*, Academic Press (1979).

MORE BOOKS IN HOMOLOGICAL ALGEBRA:

- 1) H. Cartan and S. Eilenberg, *Homological Algebra*, Princeton University Press (1956).
- 2) E. Enochs & O. Jenda, *Relative Homological Algebra*, Gruyter Expositions in Mathematics: Vol. 30 (2000).
- 3) P. Hilton and U. Stambach, *A Course in Homological Algebra*, Springer-Verlag (1971).
- 4) D. Northcott, *An Introduction to Homological Algebra*, Cambridge University Press (1960).
- 5) C. Weibel, *An Introduction to Homological Algebra*, Cambridge University Press, Cambridge (1994).

FURTHER READING:

- 1) L. Fuchs & L. Salce, *Modules over Non-Noetherian Domains*, AMS (2000).
- 2) S. Lang, *Algebra (revised 3rd edition)*, Springer (2002).
- 3) H. Matsumura, *Commutative Ring Theory*. Cambridge University Press (2004).
- 4) R. Wisbauer, *Foundations of module and ring theory, A handbook for study and research*, Gordon and Breach Science Publishers (1991).

GRADING POLICY:

Take-home Exam I	200 Points
Take-home Exam II	200 Points
Project	100 Points

SYLLABUS

Chapter	Sec.	Core Material	Week(s)
1) Categories (including selected parts of Chapter 7)	1.1.	<i>Categories and Functors</i> (including parts of 7.1, 7.2 & 7.3)	1
2) Modules (including selected parts of Chapters 7, 8 and 9)	2.1.	<i>Generalities</i> (including <i>Limits and Colimits</i> 8.1.)	2
	2.2.	<i>Tensor Products</i>	
	2.3.	<i>Exactness of Functors</i>	3
	2.4.	<i>Review of Projectives, Injectives, and Flats</i> (including <i>Injective Envelopes</i> 9.1.) - (semi)hereditary rings - Von Neumann regular rings	
		<i>Watt's Theorems</i> (Rotman pp. 75-81)	4
3) Ext and Tor (including selected parts of Chapters 6 and 7)	3.1.	<i>Complexes and Projective Resolutions</i>	5
	3.2.	<i>Long Exact Sequences</i> (including parts of 6.3, 6.4, 6.5 & 7.7)	6
	3.3.	<i>Flat Resolutions and Injective Resolutions</i>	7
	3.4.	<i>Consequences</i>	
First Take-Home Exam			
4) Dimension Theory	4.1.	<i>Dimension Shifting</i>	8
	4.2.	<i>When Flats are Projectives</i>	
	4.3.	<i>Dimension Zero (semisimple rings)</i>	9-10 (3 lectures)
	4.4.	<i>An Example</i>	
5) Change of Rings	5.1.	<i>Computational Considerations</i>	11
	5.2.	<i>Matrix Rings</i>	
	5.3.	<i>Polynomials (Hilbert's Syzygy's Theorem & Serre's Theorem)</i>	12
	5.4.	<i>Quotients and Localization</i>	13
Second Take-Home Exam			
6) Derived Functors	6.1.	<i>Additive Functors</i>	14
	6.2.	<i>Derived Functors</i>	
		<i>Selected parts of 6.3-6.6 will be embedded in pervious sections</i>	
7) Abstract Homological Algebra		<i>Selected parts of 7.1 – 7.3 & 7.6 - 7.7 will be embedded in previous chapters</i>	
Catching Up/ Presentations		<i>Homological Lemmas</i> (selected books & research papers)	15-16 (3 lectures)