Fundamentals of modern optics
(2015/2016 WS)

by Prof. Thomas PERTSCH
at Abbe School of Photonics, Friedrich-Schiller-Universität Jena
in winter term 2015/2016

LECTURES:	Monday, 08:15-09:45, lecture hall 2, physics building 2, Helmholtzweg 5
	Friday, 08:15-09:45, lecture hall 2, Abbeanum, Fröbelstieg 1
SEMINARS:	Monday, 12:00–14:00, seminar room 5, Helmholtzweg 4 (by SARAVI)
	Monday, 14:00–16:00, seminar room 3, Max-Wien-Platz 1 (by SINGH)
	Wednesday, 10:00–12:00, seminar room 5, Helmholtzweg 4 (by LÖCHNER)

Lecturer

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Seminar teachers

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- Normally seminar task sheets are distributed on Friday after the lecture.
- Normally solutions must be returned the following Friday before the beginning of the lecture or as stated on the task sheet. Please use a new sheet of paper for every task.
- Corrected solutions will be returned in the seminars.

Midterm exam

Type:	written test examination without any documents and without calculator, too
Subject:	content of lectures and seminars
Date/time:	14.12.2015, 8:15 am
Duration:	90 minutes
Location:	lecture hall 2, physics building 2, Helmholtzweg 5

Final exam

Type:	written examination without any documents and without calculator, too
Subject:	content of lectures and seminars
Date/time:	15.02.2016, 10:00 am
Duration:	90 minutes
Location:	

Retake of exam

Date/time:	22.03.2013, 10:00 am
Duration:	90 minutes
Location:	

Grading

The final grade will be determined by 70% from the grade of the final exam and by 30% from the results of the seminar tasks. The final exam must be passed to pass the entire course. An extra 15% positive influence on the final grade can be derived from the midterm exam.

Literature

- lecture script which can be downloaded from the lectures webpage
- B. E. A. Saleh and M. C. Teich, “Fundamentals of Photonics,” Wiley (2007) – fits well to the course.
- E. Hecht, "Optics," Addison-Wesley (2001) – gives more intuitive explanation of several phenomena.
- M. Born and E. Wolf, "Principles of Optics," Cambridge University Press (1999) – advanced topics covered in more detail.
- and list of books given in the first lecture

Miscellaneous

All lecture scripts and additional material will be posted at: www.iap.uni-jena.de/teaching

Lecture and seminar schedule

#	Date	Topics	Script (up to page)
L01	19.10.	Introduction and Maxwell's equations I	27
S01	W43	Fourier transform; delta distribution	
L02	23.10.	Maxwell’s equations II	30
L03	26.10.	Optical properties of matter; classification of types of media	34
S02	W44	Vector analysis; Stokes’ theorem; Maxwell’s equations; Polarization	
L04	30.10.	Material models	44
L05	02.11.	Poynting vector and energy balance	47
S03	W45	Poynting vector and continuity equation	
L06	06.11.	Normal modes in homogeneous isotropic media	52
L07	09.11.	Plane wave solutions in different frequency regimes	56
S04	W46	Lorentz model, normal modes, and vector waves	
L08	13.11.	Beams and pulses – analogy of diffraction and dispersion	60
L09	16.11.	Arbitrary narrow beams (cont.) & Fresnel- (paraxial) approximation	65
S05	W47	Diffraction in Fresnel approximation (slit, Talbot effect, Airy waves)	
L10	20.11.	Paraxial wave equation	69
L11	23.11.	Propagation of Gaussian beams	74
S06	W48	Fresnel approximation, paraxial wave equation, Gaussian beams	
L12	27.11.	Gaussian optics with q-parameter formalism	80
L13	30.11.	Resonator stability and higher order modes; Pulse propagation	85

S07	W49	Gaussian optics (telescope, laser beam, resolution limit, retrorefl.)	
L14	04.12.	Dynamics of pulsed beams described by differential equation	89
L15	07.12.	Pulse dynamics without spatial effects	95
S08	W50	Preparation for midterm exam	
L16	11.12.	Diffraction theory – derivation of Fraunhofer approximation	103
	14.12.	MIDTERM EXAM	
S09	W51	Propagation of Gaussian pulses (dispersion compensation, SVEA, …)	
L17	18.12.	Diffraction theory – Examples of Fraunhofer diffraction pattern	109
L18	04.01.	Fourier optics – optical filtering	116
S10	W02	Fraunhofer diffraction (gratings, near field diffraction)	
L19	08.01.	Polarization of electromagnetic waves	123
L20	11.01.	Crystal optics – susceptibility, crystal classes, index ellipsoid	128
S11	W03	Fourier optical filtering, anisotropic materials	
L21	15.01.	Normal modes for arbitrary propagation direction in index ellipsoid	129
L22	18.01.	Normal surfaces of normal modes	133
S12	W04	Optical wave plates, double refraction, principal component analysis	
L23	22.01.	Uniaxial crystals & optical fields in piecewise homogeneous media	138
L24	25.01.	Matrix method, Reflection – transmission problem	145
S13	W05	Jones formalism, interfaces, total internal reflection	
L25	29.01.	Single interface	152
L26	01.02.	Total internal reflection, Brewster angle, Bragg-mirrors	159
S14	W06		
L27	05.02.	Periodic multilayer systems	164
L28	08.02.	Fabry-Perot-resonators	169
S15	W07		
L29	12.02.	Guided waves in layer systems	173
E01	15.02.	Exam (10:00-11:30,)	
E02	22.03.	Retake (10:00-11:30,)	