

FYS3410 - Vår 2016 (Kondenserte fasers fysikk)

<http://www.uio.no/studier/emner/matnat/fys/FYS3410/v16/index.html>

**Pensum: Introduction to Solid State Physics
by Charles Kittel (Chapters 1-9 and 17, 18, 20)**

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2016 FYS3410 Lectures (based on C.Kittel's Introduction to SSP, Chapters 1-9, 17,18,20)

Module I – Periodic Structures and Defects (Chapters 1-3, 20)

M18/1: 9-12 am	Introduction. Crystal bonding. Periodicity and lattices, Brag diffraction and Laue condition, reciprocal space	3h
<i>W20/1 cancelled</i>		
M25/1: 9-12 am	Ewald construction, interpretation of a diffraction experiment , Brag planes, and Brillouin zones	3h
<i>W27/1 cancelled</i>		
M01/2: 10-12 am	Elastic strain and structural defects in crystals	2h
W03/2: 9-10 am	Atomic diffusion in solids	1h
M08/2: 10-12 am	Summary of Module I	2h

Module II – Phonons (Chapters 4 and 5)

W10/2: 9-10 am	Vibrations in monoatomic and diatomic chains of atoms	1h
M15/2: 10-12am	Periodic boundary conditions, phonons and density of states (DOS)	2h
W17/2: 9-10 am	Planck distribution	1h
M22/2 : 10-12am	Lattice heat capacity: Dulong-Petit, Einstein, and Debye models	2h
<i>W24/2 cancelled</i>		
M29/2: 9-12am	Comparison of different models for lattice heat capacity, thermal conductivity with phonons	3h
W02/3: 9-10 am	Thermal expansion	1h
M07/3: 10-12am	Summary of Module II.	2h

Module III – Electrons (Chapters 6, 7, 18 - pp.528-530, and Appendix D)

W09/3: 9-10 am	Free electron gas (FEG) versus free electron Fermi gas (FEFG)	1h
M14/3: 10-12am	DOS of FEFG in 3D. Effect of temperature – Fermi-Dirac distribution	2h
W16/3: 9-10 am	Heat capacity of FEFG in 3D	1h
W30/3: 9-10 am	DOS in 2D - quantum wells	1h
M04/4: 10-12am	DOS in 1D and 0D, i.e. quantum wires and quantum dots; transport properties of electrons	2h
W06/4: 9-10 am	Origin of the energy band gap	
M11/4: 10-12am	Nearly free electron model. Kronig-Penney model. Empty lattice approximation.	2h
W13/4: 9-10 am	Number of orbitals in a band	1h
M18/4: 10-12am	Summary of Module III.	2h

Module IV – Semiconductors and interfaces (Chapters 8, 9-pp 223-231, 17)

W20/4: 9-10 am	Metals versus semiconductors. Surfaces and interfaces.	1h
M25/4: 9-12 am	Effective mass method.	3h
W27/4: 9-10 am	Intrinsic carrier generation – electrons and holes.	1h
M02/5: 9-12 am	Localized levels for hydrogen-like impurities – donors and acceptors. Doping.	3h
W04/5: 9-10 am	Carrier statistics in semiconductors	1h
M09/5: 9-12 am	p-n junctions	3h
W11/5: 9-10 am	Optoelectronic semiconductor properties and devices	1h
M18/5: 9-12 am	Device demonstrations. Summary of Module IV	3h

Repetition

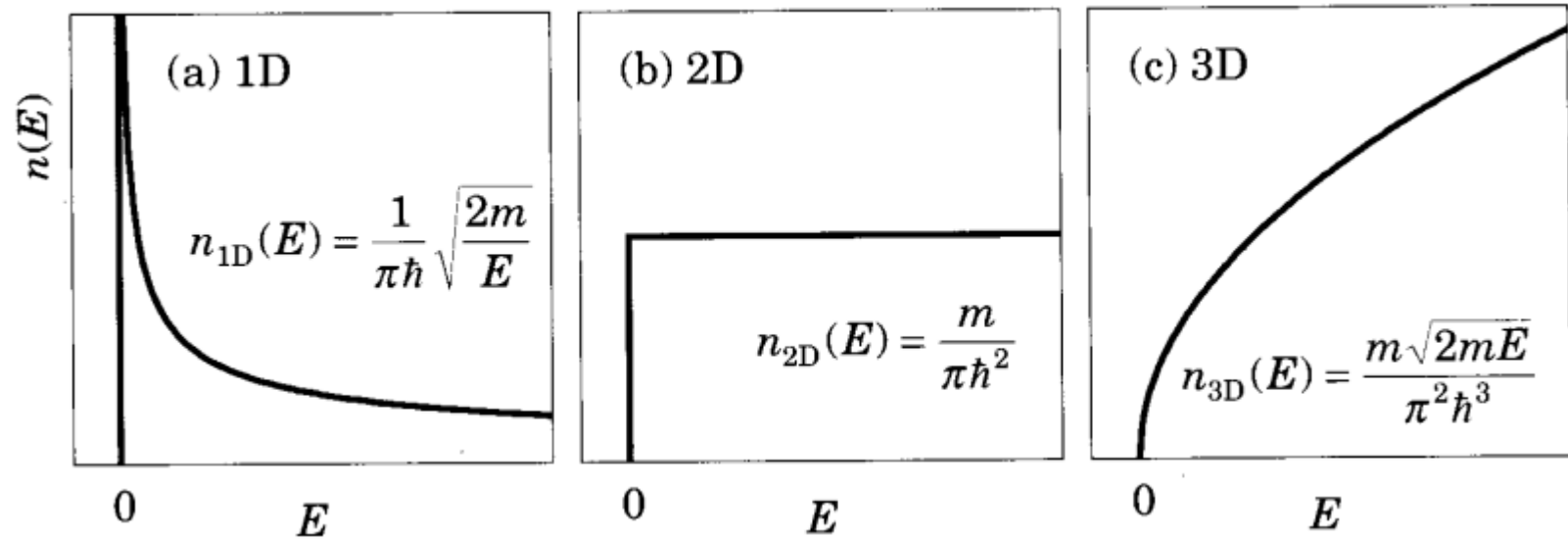
M23/5 9-12 am	The course in a nutshell	2h
<i>W25/5, M30/5 and W1/6 cancelled</i>		

Exam during week 22 (tentatively 30-31/5)

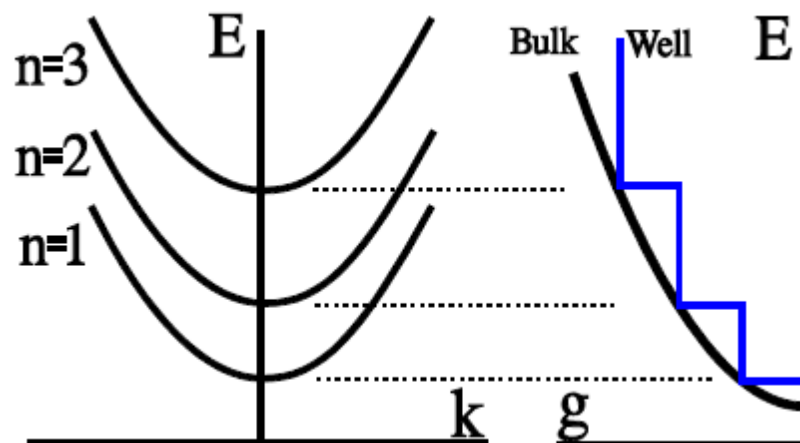
FEFG in nanostructures

- (i) Motivation: intriguing carrier recombination in QW resulting in photons with energies above the band gap;**
- (ii) DOS for low-dimensional FEFG**
- (iii) DOS in quantum wells**
- (iv) DOS in nanowires**
- (v) DOS in quantum dots**

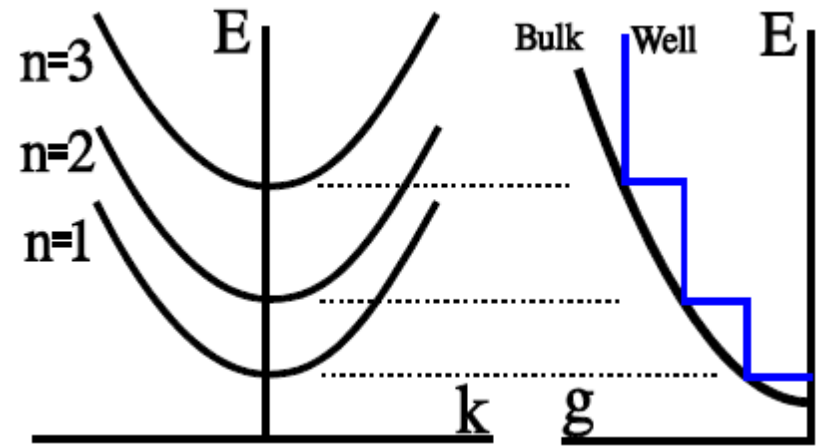
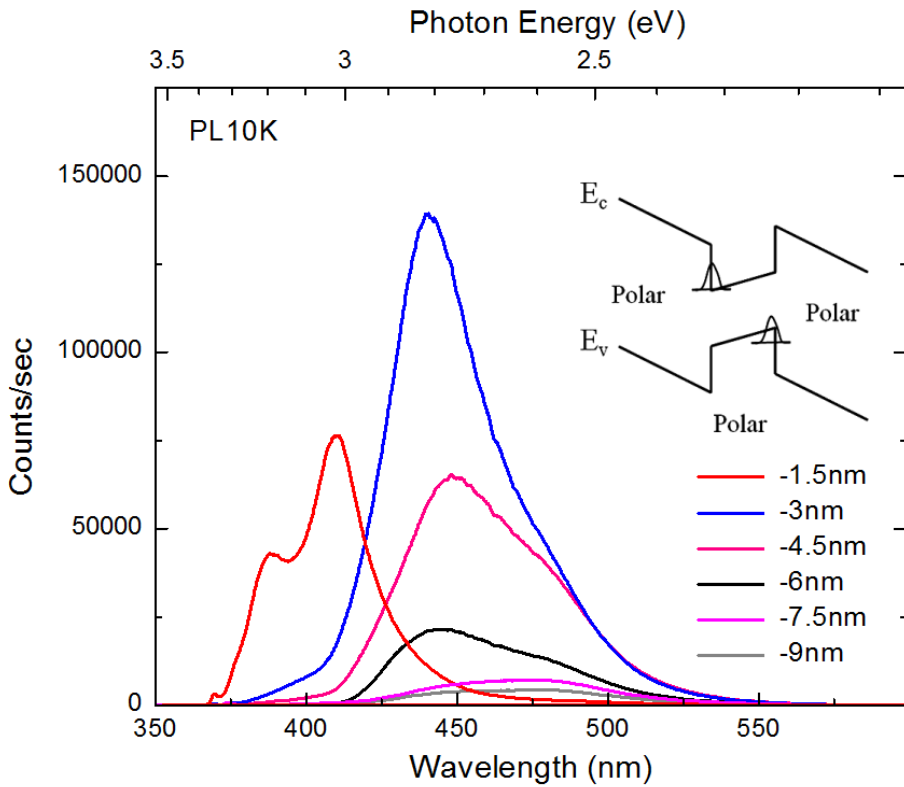
DOS for low-dimensional FEFG



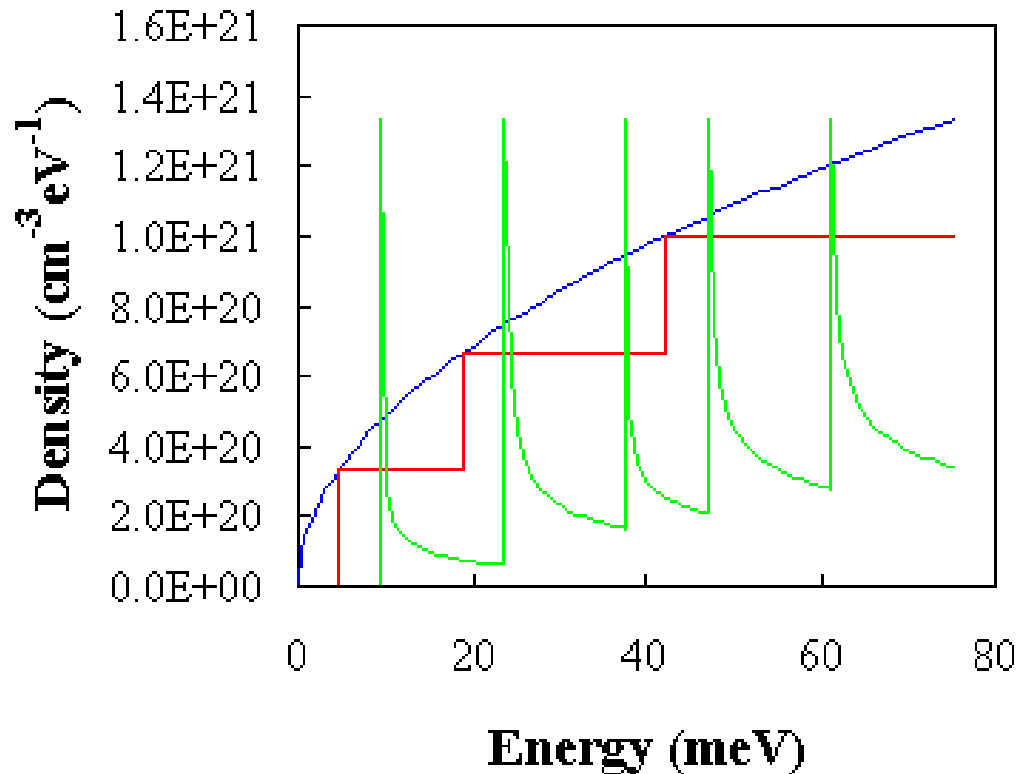
DOS in quantum wells



DOS in quantum wells



DOS in nanowires and quantum dots



Density of states per unit volume and energy for a 3-D semiconductor (blue curve), a 10 nm quantum well with infinite barriers (red curve) and a 10 nm by 10 nm quantum wire with infinite barriers (green curve).

DOS in nanowires and quantum dots

Quantum Well			Quantum Wire				Quantum Box				
n_x	E/E_0	Degeneracy	n_x	n_y	E/E_0	Degeneracy	n_x	n_y	n_z	E/E_0	Degeneracy
1	1	1	1	1	2	1	1	1	1	3	1
2	4	1	1	2	5	2	1	1	2	6	3
3	9	1	2	2	8	1	1	2	2	9	3
4	16	1	1	3	10	2	1	1	3	11	3
5	25	1	2	3	13	2	2	2	2	12	1
6	36	1	1	4	17	2	1	2	3	14	6
7	49	1	3	3	18	1	2	2	3	17	3
8	64	1	2	4	20	2	1	1	4	18	3
9	81	1	3	4	25	2	1	3	3	19	3
10	100	1	1	5	26	2	1	2	4	21	6
11	121	1	2	5	29	2	2	3	3	22	3
12	144	1	4	4	32	1	2	2	4	24	6
13	169	1	3	5	34	2	1	3	4	26	3
14	196	1	1	6	37	6	1	1	5	27	3
15	225	1	2	6	40	13	3	3	3	27	1
							3	2	4	29	3