This course provides a basic but solid quantitative introduction to the theory behind remote sensing of Earth from (air- and) space-crafts. Current and next-generation satellites measure the spectrum and angular distribution of the intensity of light, as well as of the polarization of light. Hence, these properties of light play a central role in this course: Which parameters describe these properties? How do they change when light is scattered, absorbed, and/or emitted by various constituents of the Earth’s system? How can we relate such changes in property of light to the physical parameters of these constituents? While much of this course is focused on remote sensing of constituents of the Earth’s atmosphere (gasses, aerosols, clouds), relevant examples are provided for remote sensing of the Earth’s surface.

Part I:  **Light**

1) **E&M**  
   → read: Sections 2.1, 2.2, 2.5, 3.1–3, 4.1, and 4.2 (optional)
   - History
   - Wave basics (*wave equation*, *harmonics*, *complex notation*, *superposition*)
   - Maxwell’s Equations (*vacuum*, *dielectrics*, *complex refractive index*)
2) **Stokes Vector** 2nd & 3rd week
   → read: Section 2.3, Pages 43-45
   - Polarization (elliptic polarization, natural light, polarizers)
   - Stokes parameters (measurements, definition, polarization ellipse)

3) **Solar Spectrum** 4th week
   → read: Chapter 6
   - Black Body (Planck’s Law, Stefan-Boltzman’s law, Wien’s law)
   - Kirchhoff’s law (emissivity, absorptivity),
   - Climate (greenhouse effect)

4) **Gaseous absorption spectra** 5th & 6th week
   → read: Chapter 3, Section 7.4.1, Chapter 9
   - Line spectra (ionization, dissociation, electronic, vibrational, rotational)
   - Line Broadening (natural, collision)
   - Remote Sensing (atmospheric temperature sounding)

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**Part II: Atmospheric Absorption, Scattering and Emission**

1) **Propagation of Light** 7th week
   → read: Section 2.7
   - Coordinates (polar coordinates; solid angle)
   - Flux (specific intensity; upward and downward flux)

2) **Radiative Transfer of Light** 8th week
   → read: Section 7.2
   - Scattering, Absorption, Extinction
   - Scattering Function and Scattering Matrix
   - Radiative Transfer (RT) Equation

3) **Absorption/Emission in the Atmosphere** 9th week
   → read: Sections 7.3, 7.4.2–3, 8.1, 8.2.1, 8.3, 11.1–3 and 7.4.3 (optional)
   - Solution of RT Equation for absorbed/emitted radiation
   - Weighting Functions (pressure broadened)

4) **Absorption/Scattering in the Atmosphere** 10th week
   → read: Sections 11.1–4
   - Solution of RT Equation for absorbed/scattered radiation
   - Successive Order of Scattering Method
   - Doubling and Adding Method

5) **Scattering properties of the Atmosphere** 11th week
   → read: Sections 12.1–4
   - Gasses (scattering properties)
- Clouds (*scattering properties*)
- Aerosols (*species; scattering properties*)

6) **Remote Sensing**

6.1 12th & 13th week

- Aerosol retrievals (*AVHRR, MODIS, MISR, POLDER*)
- Comparisons (*AERONET*)
- Future? (*APS, MSPI*)