# Proposal for a new modular course

**1. Modular Course No:** SPA 6xx

**2. Modular Course Name:** Introduction to radiative processes

**3. Class strategy:** Lectures per week: 3 (L), Tutorial: 0 (T), Laboratory: 0 (P), Additional hours: (0-2): 0 (A), Duration of Course: half semester, Module credit: 5 (3-0-0-0)

**4. Proposing department:** SPASE

**5. Proposing Instructor:** Kartick Sarkar

**6. Course Description:**

**A. Objective:** Studying the universe is mostly done via understanding the electromagnetic radiation that each source emits. The nature of the spectrum indicates the underlying physical processes. This course intends to teach the processes that generate electromagnetic radiation.

**B. Content:**

i. **Ionization processes (3 L):** Basic quantum mechanics concepts (energy levels, wave-particle duality), Collisional ionization, photo-ionization, recombination, ionization equilibrium, HII regions (Stromgren sphere), Saha ionization

ii. **Emission and absorption of thermal plasma (5 L)**: Bound-Bound transitions, Spontaneous/stimulated transitions, Einstein's coefficient, emission/absorption lines, emissivity and absorption coefficient, doppler/Lorentz broadening, Free-Free emission, Thompson scattering, example of a spectrum and its features

iii. **Heating and Cooling (2L)**: Photo-heating, cooling curve, thermal equilibrium, thermal instability, multiphase gas (interstellar medium)

iv. **Radiative Transfer (6 L)**: Radiative transfer equation, thermal radiation (Kirchhoff's law, blackbody radiation, Rayleigh-Jeans law), brightness temperature, Scattering and diffusion, radiation as a fluid (Eddington approximation), gray atmosphere, green house effect

v. **Non-Thermal Radiation (4 L)**: Synchrotron Radiation, beaming effect, polarization, Compton/inverse-Compton Scattering

**C. Prerequisites**: None

**D. Short summary for including in the course study booklet**: Ionization states of a plasma, emission and absorption processes, heating and cooling, radiative transfer

**7. Books and references:**

1. *Physics of the Interstellar and Intergalactic Medium:* Bruce Draine
2. *Radiative Processes in Astrophysics:* Rybicki & Lightman