Course Title: Astronomical Instrumentation
Course Instructor: Sabyasachi Chattopadhyay, Nicolas Erasmus, Siddharth Maharana
Course Credits: 1
Lecture Hours: 24
Lab/practical Hours: 10

1. **Course Overview:**
   This is an advanced course on optical-IR astronomical instrumentation which aims to develop understanding of practical issues of instrument development in students. The course consists of 24 hours of lectures divided into 6 sections : detectors, optics, spectroscopy, polarimetry, adaptive optics and photonics. Individual sections would have their associated lab/practical sessions to be hosted at SAAO. The sections are associated with preliminary assessment of assignments and quizzes along with a project, a midterm and a final exam. This course is geared towards making students knowledgeable for participating in instrumentation discussions as well as readying them to design instruments specific to different scientific goals.

2. **Course Break Down:**
   a. Detectors: Week 4 February
      Preliminary assessment method : Quiz
      Lecture Hours: 4, 2 lectures 2 hours each
      Lab Hours: 2, Week 3 March
      i. Quantum Efficiency
      ii. Semiconductor
      iii. CCD and CMOS detectors
      iv. Charge Transfer
      v. Readout Electronics
      vi. Electronic Noise
   b. Optics: Week 1 March
      Preliminary assessment method : Assignment
      Lecture Hours: 4, 2 lectures 2 hours each
      Lab Hours: 2, Week 4 March
      i. Geometric/ray optics
      ii. Aberrations
      iii. Designing optical systems
      iv. Interference
      v. Diffraction
   c. Polarimetry: Week 3 February
      Preliminary assessment method : Assignment
      Lecture Hours: 4, 2 lectures 2 hours each
      Lab Hours: 2, Week 4 April
      i. Light vectors
      ii. Stokes parameters
      iii. Measurement
      iv. Error propagation
   d. Spectroscopy: Week 2 March
      Preliminary assessment method : Assignment
      Lecture Hours: 4, 2 lectures 2 hours each
      Lab Hours: 2, Week 2 May
      i. Anamorphic magnification
      ii. Diffraction grating
      iii. Echelles
      iv. Grating efficiency
      v. Integral field spectroscopy
      vi. Multi-object spectroscopy
   e. Astro-photonics: Week 2 April
      Preliminary assessment method : Quiz
      Lecture Hours: 4, 2 lectures 2 hours each
      Lab Hours: 2, Week 3 May
      i. Waveguides principles
      ii. Transmission losses in waveguides
      iii. Focal ratio degradation

iv. Photonic lanterns
v. Arrayed WaveGuides

f. Adaptive Optics: Week 3 April
Preliminary assessment method : Quiz
Lecture Hours: 4, 2 lectures 2 hours each
i. Atmospheric seeing
ii. Turbulence and mitigation
iii. Strehl Ratio
iv. AO systems (phase space)
v. AO systems (mode space)

3. Resources: (only for further reading)

a. Astronomical Optics by Daniel Schroeder
b. To Measure the Sky by Frederick Chromey
c. Detection of Light, by George H. Rieke

4. Breakdown of lab/practical tasks:

a. Detectors: Measure Gain and Read Noise
b. Optics: Characterize spherical aberration
c. Spectroscopy: Measure resolving power
d. Polarimetry: Measure polarization from supplied data
e. Astro-photonics: Measure focal ratio degradation

5. Requirements of attending the course:

a. Undergraduate physics
b. School mathematics

6. Skills to be developed during the course:

a. Deriving instrument specific requirements from astronomical science goals
b. Ability to participate in instrument related discussion

7. Assessment:

a. Assignment: 12% (4% each)
b. Quiz: 12% (4% each)
c. Attendance: 10%
d. Practical: 20% (4% each)
e. Project: 11%
f. Midterm: 15%
g. Final: 20%