Indian Institute of Technology, Kanpur

Proposal for a New Course

1. Course No: A **600 level elective** number requested. PHY 685
2. Course Title: ***Introduction to Quantum Field Theory***
3. No. of Lectures per week: 3 (L), Tutorial: 1 (T), Laboratory: 0 (P), Additional Hours[0-2]: 0 (A),

   Credits (3*L+2*T+P+A): 11 Duration of Course: Full Semester
4. Proposing Department/IDP : PHY.

   Other Departments/IDPs which may be interested in the proposed course: MTH.

   Other faculty members interested in teaching the course: Joydeep Chakrabortty, Diptarka Das, Nilay Kundu, Apratim Kaviraj, Debtosh Chowdhury, Sabyasachi Chakraborty.
5. Proposing Instructor: Arjun Bagchi (PHY)
6. Course Description:

   A) Objectives: Quantum field theory is the basic framework of understanding the laws of nature and the basic building blocks of the universe. This is fundamental to all branches of theoretical physics starting from condensed matter physics to the theory of elementary particles. This course is a first course on the subject aimed at students who have a background of quantum mechanics and statistical mechanics.

   B) Contents:

S. No.	Broad Title	Topics	No. of Lectures
1.	Introduction and Classical field theory	• Why QFT • From point particles to classical fields • Some basics of Lie groups and Lie algebras • Symmetries and Noether's theorem	6
2.	Canonical Quantization of free scalar fields	• Klein-Gordon Equation • Simple Harmonic Oscillator • Free Quantum Fields • Complex Scalar Fields • Causality and Propagators	7
3.	Interacting fields	• Interaction Picture, Scattering, Wick's Theorem. • Feynman Diagrams and Feynman Rules • Amplitudes, Decays and Cross Sections, Green's Functions • Connected Diagrams and Vacuum Bubbles	9
4.	Fermions and their quantization	• Lorentz Group, Clifford Algebras and Spinor Representation • The Dirac Lagrangian and the Dirac equation • Symmetries and Currents, Plane Wave Solutions • Fermionic Quantization • Propagators, Feynman Rules	8
5.	Quantum Electrodynamics	• Gauge Invariance and Quantization • Including Matter • Propagators, Feynman Rules • QED Processes.	9
		Total number of lectures:	39

C) Pre-requisites: PHY421, PHY431, PHY 432, PHY422 (Desirable).

D) Short summary for including in the Courses of Study Booklet: Quantum field theory is the basic framework of understanding the laws of nature and the basic building blocks of the universe. This is fundamental to all branches of theoretical physics starting from condensed matter physics to the theory of elementary particles. This course is a first course on the subject aimed at students who have a background of quantum mechanics and statistical mechanics.

7. Recommended books:
   - M. Peskin and D. Schroeder: *An Introduction to Quantum Field Theory*
   - S. Weinberg: *The Quantum Theory of Fields: Vol 1.*
   - M. Scredniki: *Quantum Field Theory*
   - L. Ryder: *Quantum Field Theory*
   - A. Zee: *Quantum Field Theory in a Nutshell.*

Dated: 31 March 2024. Proposer: Arjun Bagchi ( ).

Dated: 31 March 2024 DPGC Convener (PHY):_____

The course is approved / not approved

_____

Chairman, SPGC

Dated:_____

PGDesk-IITK-DOAA

From: spgc@iitk.ac.in
Sent: 23 April 2024 17:09
To: dpgc_phy
Cc: pgdesk@iitk.ac.in
Subject: Re: Fwd: Proposal of a PHY PG elective course

@ Raviji - Please do the needful if everything is in order.

> Dear SPGC Chairman,
>
> Please find below link of a PG course that was circulated among all
> the faculty members of IITK. No comment has been received. Kindly
> process it further as per the established protocol for approval and
> allotment of appropriate course number. Thanks.
>
> Regards,
> Sagar
>
> Cc: Proposing instructor
>
> -------- Original Message --------
> Subject: Proposal of a PHY PG elective course
> Date: 2024-04-01 14:25
> From: dpgc_phy <dpgc_phy@iitk.ac.in>
> To: Acadstaff <acadstaff@lists.iitk.ac.in>
>
> Dear Colleagues,
>
> Please find in the link,
> https://iitk.ac.in/doaa/data/NewCourses/Course-proposal-PHY6XX-Introdu
> ction-to-Quantum-Field-Theory.pdf,
> a proposal for a PG elective course. If you have comments/suggestions,
> then please send them as replies to this email (with cc to
> abagchi@iitk.ac.in) by
> 21 April 2024.
>
> Regards,
> Sagar
> On behalf of DPGC (PHY)
>
> P.S.: This course (with number PHY681) has been successfully running
> for past many years. This proposal only seeks to add a tutorial to the
> already existing course.
>

Phy.

Scan/SSC
06/06/24

INDIAN INSTITUTE OF TECHNOLOGY KANPUR
POSTGRADUATE OFFICE

No. A(P)/IITK/course approval/
June 5, 2024

The Convener, DPGC
Departments of CE/SEE/PHY
IIT Kanpur

I am directed to communicate the concurrence of the SPGC (2023-24) in its 9th meeting held on 28/05/2024 for the approval of new PG course proposal. After detailed discussion the following courses were approved.

Course No	Title	Credits	Instructor	SPGC /Decision
CE716	Project Management and Control	3-0-0-0-9	Dr. Chirag Kothari	Approved
CE718	Water resources systems analysis	3-0-0-0-9	Dr. Tushar Apurv	Approved
CE719	Hydrometeorology	3-0-0-0-9	Dr. Tushar Apurv	Approved
SEE631	Sustainable Forest Management	3-0-0-0-9	Dr. Ashish Garg	Approved
PHY685	Introduction To Quantum Field Theory	3-0-0-0-11	Dr. Arjun Bagchi	Approved

Joint Registrar
Academic Affairs

CC: OARS (DOAA Office) For necessary action