



University of Karachi

Institute of Space Science and Technology

2021 Session

Pre-requisite: SST 501: Classical Mechanics

SST 602: Quantum Mechanics (3+0)

Activity	Dates	Class Schedule
Teaching	September 7, 2021 – January 6, 2022	In-Class Sessions: Wednesday 1710h-1800h;
Semester Examinations	January 10-31, 2022	Thursday 1710h-1850h in R106, ISST Bldg.
Semester break	February 1-6, 2022	75% attendance needed to appear in final exam

Course Supervisor: **Professor Dr. Syed Arif Kamal**

PhD; MSc summa cum laude (Karachi); MA (Astrophysics), Johns Hopkins, United States;
MS (Mathematical Physics), Indiana, Bloomington, United States

Special courses in Space Physics, Astrophysics, Gravitation and Cosmology at MSc and MS levels
Former Senior Scientific Officer, Control Systems Laboratories and Consultant, Guidance,
Navigation and Control Laboratories, SUPARCO (Plant), Pakistan Space and Upper Atmosphere
Research Commission, Karachi; Visiting Faculty, Department of Aeronautics and Astronautics,
Institute of Space Technology, Islamabad; e-mail: profdrakamal@gmail.com

Handout Address: https://www.ngds-ku.org/ISST/SST602/SST602_21.pdf

Course Objectives

To give the students an introduction to the philosophy and the special techniques used in quantum mechanics for applications in upper-atmosphere physics, space physics, astrophysics and cosmology.

Higher Education and Job Opportunities

MS/MPhil/PhD from Department of Mathematics/Physics or ISST, MS from IST (Islamabad); jobs in SUPARCO, NDC, PAF or Met office

Course Outline

Week 1 — Introduction to quantum mechanics

Week 2 — Unit A: Waves and particles, Heisenberg's uncertainty principle, quantum mechanics, wave function

Week 3 — Unit B: Schrödinger wave equation, wave function of a free particle

Week 4 — Unit C: Time-independent- and time-dependent-Schrödinger wave equation, applications of Schrödinger wave equation

Assignment 1 (maximum marks: 10)*

Week 5 — Unit D: Potential well

Week 6 — Unit E: Potential barrier and tunneling of particles

Week 7 — Unit F: Harmonic oscillator and rigid rotators

Week 8 — Unit G: Hydrogen atom

Assignment 2 (maximum marks: 10)[§]

Week 9 — Unit H: Operator algebra, orthogonal and orthonormal wave functions

Week 10 — Unit I: Probability density, probability current density,

Week 11 — Unit J: Angular momentum and spin of particles

Week 12 — Unit K: Pauli exclusion principle, wave functions of fermions and bosons

Week 13 — Unit L: Time-independent-perturbation theory

Week 14 — Unit M: Time-dependent-perturbation theory

Weeks 15, 16 — Revision and solution of sample paper

Recommended Reading

Cohen-Tannoudji, C., Diu, B. & Laloë, F. (1977). *Quantum Mechanics, Vol. I & II*, Hermann, Paris, France & John Wiley, New York, United States

Messiah, A. (2014). *Quantum Mechanics*, Vol. I & II, Dover, New York, United States

Sakurai, J. J. & Napolitano, J. J. (2010). *Modern Quantum Mechanics*, 2nd Ed., Addison Wesley, Reading, Ma., United States

Thankappan, V. K. (2014). *Quantum Mechanics*, 4th Ed., New Academic Science, New York, United States

*https://www.ngds-ku.org/ISST/SST602/Assignments/Assignment_1.pdf (due: Thu., Oct. 7, 2021 at the start of class — 5: 10 p. m.)

[§]https://www.ngds-ku.org/ISST/SST602/Assignments/Assignment_2.pdf (due: Final-exam day at the start of exam — 4: 00 p. m.)



SST 602: Quantum Mechanics I (3+0)

Course Plan

Active link (RGB 0 0 255) • To be uploaded next (RGB 0 128 0) • To be uploaded later (RGB 128 0 0)

Week	Dates	Wednesday	Thursday
SEPTEMBER 2021			
01	15, 16	Course policies https://www.ngds-ku.org/ISST/SST602/Handouts/Introductory.pdf	Introductory
02	22, 23	NO CLASS (Urs of Shah Abdul Latif Bhittai) https://www.ngds-ku.org/ISST/SST602/Handouts/Review_Int.pdf	Review Introductory
03	29, 30	Unit A https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_A.pdf	Review A https://www.ngds-ku.org/ISST/SST602/Handouts/Review_A.pdf
OCTOBER 2021			
04	06, 07	Unit B https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_B.pdf	Review B https://www.ngds-ku.org/ISST/SST602/Handouts/Review_B.pdf
05	13, 14	Unit C https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_C.pdf	Review C https://www.ngds-ku.org/ISST/SST602/Handouts/Review_C.pdf
06	20, 21	Unit D https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_D.pdf	Review D https://www.ngds-ku.org/ISST/SST602/Handouts/Review_D.pdf
07	27, 28	Unit E https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_E.pdf	Review E https://www.ngds-ku.org/ISST/SST602/Handouts/Review_E.pdf
NOVEMBER 2018			
08	04, 05	Unit F https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_F.pdf	Review F https://www.ngds-ku.org/ISST/SST602/Handouts/Review_A.pdf
09	11, 12	Unit G https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_G.pdf	Review G https://www.ngds-ku.org/ISST/SST602/Handouts/Review_G.pdf
10	18, 19	Unit H https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_H.pdf	Review H https://www.ngds-ku.org/ISST/SST602/Handouts/Review_H.pdf
11	25, 26	Unit I https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_I.pdf	Review I https://www.ngds-ku.org/ISST/SST602/Handouts/Review_I.pdf
DECEMBER 2018			
12	02, 03	Unit J https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_J.pdf	Review J https://www.ngds-ku.org/ISST/SST602/Handouts/Review_J.pdf
13	09, 10	Unit K https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_K.pdf	Review K https://www.ngds-ku.org/ISST/SST602/Handouts/Review_K.pdf
14	16, 17	Unit L https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_L.pdf	Review L https://www.ngds-ku.org/ISST/SST602/Handouts/Review_L.pdf
15	23, 24	Unit M https://www.ngds-ku.org/ISST/SST602/Handouts/Handout_M.pdf	Review M https://www.ngds-ku.org/ISST/SST602/Handouts/Review_M.pdf
16	30, 31	Revision https://www.ngds-ku.org/ISST/SST602/Exams/Solution_Sample_Paper.pdf	Solution of Sample Paper

- Final exam: 80%, best assignment counted: 20%; **all assignments due at the start of class** (50% marks deduction for late submission); attendance record and assignment marks https://www.ngds-ku.org/ISST/SST602/Record602_21.pdf
- ZOOM session of 40-minute duration shall be arranged 2 days before the final examination for any last-minute clarification.
- A follow-up ZOOM session shall be arranged through mutual consent to finish the planned coverage of that week and discuss anything, which is not clear during face-to-face sessions.

ZOOM ID: 389-507-8708 • Passcode: Ufvnm3 • Numeric Passcode: 452023
 Invite Link: <https://us04web.zoom.us/j/3895078708?pwd=Y2hGbmhBa3J0Mm81aU9pYmt0Rm5UZz09>

Updated: Wednesday, Rabi-ut-Thani 11, 1443 AH; November 17, 2021 AC