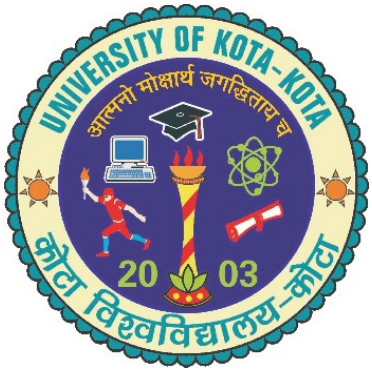
UNIVERSITY OF KOTA

SCHEME OF EXAMINATION

AND

COURSES OF STUDY



Department of Pure & Applied Physics
Faculty of Science

M.Tech. (Solar Energy)

Third Semester Examination, December 2023
Fourth Semester Examination, June 2024

UNIVERSITY OF KOTA

MBS Marg, Near Kabir Circle, KOTA (Rajasthan)-324 005

INDIA

Edition: 2023

Course Structure with Distribution of Marks

Year / Semester	Serial Number, Code & Nomenclature of Paper			Duration of Exam.	Teaching Hrs/Week & Credit			Distribution of Marks			Min. Pass Marks		
	Number	Code	Nomenclature		L	P	C	Conti. Assess.	Sem. Assess.	Total Marks	Conti. Assess.	Sem. Assess.	Total Marks
II Year III Sem	3.1	SOL301	Modeling, Simulation and Decision Making	3 Hrs	4		4	30	70	100	12	28	40
	3.2	SOL302	Solar PV Power Plants	3 Hrs	4		4	30	70	100	12	28	40
	3.3	SOL 303	Seminar (R&D)		4		4	30	70	100	12	28	40
	3.4	SOL 304	Seminar (Industry-Society-Policies)		4		4	30	70	100	12	28	40
	3.5	SOL305	Research Project Phase I			16	8	60	140	200	30	70	100
	3.6	--	CBCS Paper		2		2	50	--	50	20	--	20
	Total				**16**	**16**	**26**	**230**	**420**	**650**	**--**	**--**	**--**
II Year IV Sem	4.1	SOL401	Research Project Phase II			48	24	180	420	600	90	210	300
						48	**24**	**180**	**420**	**600**	**--**	**--**	**--**

Objectives of the Course:

Innovation and Employability-With the growth in the power and renewable energy sector, the requirement of trained and skilled manpower has increased and will increase manifold in coming years. The successful implementation and running of the projects will depend on the availability of the skilled personnel. As government is laying impetus on utilization of solar energy through Jawaharlal Nehru National Solar Mission, many companies and many small and big projects on solar energy are coming up which require manpower trained in solar energy technologies. It is estimated that around 150 thousand jobs are there in field of solar energy utilization in India. In India very few institutes offer courses specialized in solar energy technologies, and nowhere in Rajasthan such course is being run, therefore this innovative course has been designed as Post Graduate course in Solar Energy. Solar energy technologies are varied and cover the areas ranging from heating, cooling, cooking, electricity production, drying, distillation, agricultural and industrial applications etc. So it is felt that a complete scientific course addressing the issues of solar energy technologies and power generation should be initiated and thus this course of Master of Technology in Solar Energy has been started from year 2014-15.

Duration of the Course:

The duration of the course is two years which has been organized in four semesters. The first three semesters would consist of theory, laboratory work, and seminar. Fourth semester would focus on research project.

Eligibility for Admission:

B. E. / B. Tech. / M.Sc. (Physics/Math/Chemistry) with Physics and Math at B.Sc. level

For GEN category candidates of Rajasthan-55%; Other state-60%; SC/ST/OBC/SOBC-Minimum Passing Marks.

- The admission shall be through Merit/Written test. The written test will be conducted in case of forms more than three times the seats available. The weightage of the individual component will be calculated as given below
    - 50% of the marks obtained in the passing examination.
    - 50% of the written test

The minimum pass marks for admission in aggregate of the above mentioned components is 40%.

- GATE qualified candidates are exempted from the entrance test for a period of two years as per the validity of the GATE score. Admission of such candidates may be made on the merit in GATE.
- Pattern of written test
  - The test will be based on objective type of questions.
  - The questions will be of scholastic aptitude type.
  - The question paper will consist of 50 questions with duration of 60 min.
  - There is no negative marking.
  - Each correct answer carries 2 marks.
- Syllabus
  - Basic mathematics (vector, matrices, determinants, calculus, trigonometry), fundamentals of computers, basic electrical and electronic circuits, fundamental thermodynamics, solar energy applications, English.

Structure of the Programme:

The programme consists of:

(i) Core and applied courses of theory as well as practical papers which are compulsory for all students.

(ii) Dissertation / Project Work / Practical training / Field work which can be done in an organization (Government, Industry, Firm, Public Enterprise, *etc.*) approved by the Department.

Attendance:

Every teaching faculty handling a course shall be responsible for the maintenance of attendance Register for candidates who have registered for the course. The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students. Each student should earn 75% attendance in the courses of a particular semester failing which he or she will not be permitted to appear in the End-Semester Examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not under any circumstance be granted for attendance below 65%.

Teaching Methodologies:

The classroom teaching would be through conventional lectures or power point presentations (PPT). The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skills. In the laboratory, instructions would be given for the experiments followed by demonstration and finally the students have to do the experiments individually.

Maximum Marks:

Maximum marks of a theory and practical paper shall be decided on the basis of their contact hours/credit per week. One teaching hour per week shall equal to one credit and carry 25 maximum marks and therefore, four teaching hours/credit per week shall carry 100 maximum marks for each theory paper/course. Each two contact hours per week for laboratory or practical work shall be equal to one credit per week and carry 25 maximum

marks and therefore, sixteen teaching hours per week shall carry 200 maximum marks for laboratory or practical work.

Scheme of Examinations:

The examination shall be divided into two parts in which first part is continuous assessment or internal assessment and second part is semester assessment or external assessment. The schemes for the internal and external examinations shall be as under:

a) The assessment of the student for theory paper shall be divided into two parts in which first part is continuous assessment or internal assessment (30% of maximum marks) and second part is semester assessment or external assessment (70% of maximum marks). For practical papers there will be only one external assessment (100% of maximum marks).

b) The internal assessment for each theory paper shall be taken by the teacher concerned in the Department during each semester. There will be two components of internal assessment; one by test having 2/3 weightage and another by seminar / assignment / presentation / quiz / group discussion / vivo of 1/3 weightage, for theory papers in each semester. Internal assessment test shall be of one hour duration for each paper and shall be taken according to academic calendar notified by the University / Departments.

c) A student who remains absent (defaulter) or fails or wants to improve the marks in the internal assessment may be permitted to appear in the desired paper(s) (only one time) in the same semester with the permission of the concerned Head of the Department. A defaulter / improvement fee of Rupees 250/- per paper shall be charged from such candidates. Duly forwarded application of such candidates by the teacher concerned shall be submitted to HOD who may permit the candidate to appear in the internal assessment after depositing the defaulter/ improvement fee. A record of such candidates shall be kept in the Department.

d) The external assessment shall be of three hours duration for each theory paper and six hours duration for practical paper. The practical examination shall be taken by the panel of at least one external and one internal examiner at the end of each semester.

e) The syllabus for each theory paper is divided into five independent units and each theory question paper will be divided into three sections as mentioned below:
   - ***Section-A*** *shall have 01 compulsory question comprising 10 questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark and total marks of this section will be 10. This section will be compulsory in the paper.*
   - ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words) and examiners are advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
   - ***Section-C*** *will contain five long answer type questions. One compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) of and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be instructed to design question paper covering from all five units.*

f) The pattern of question paper of internal and external shall be as follows:

(A) Continuous or Internal Assessment:

30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks)

DEPARTMENT OF PURE & APPLIED PHYSICS
UNIVERSITY OF KOTA, KOTA
First/Second Internal Test 20…….

Duration of Exam: 1.00 Hr	**Max. Marks: 20**
Class: M.Tech (Solar Energy)	**Semester:**
Subject:	**Paper:**
No. of Students:	**Teacher:**

Note: The question paper contains three sections as under:
Section-A : One compulsory question with 04 parts. Please give short answers in 20 words for each part.
Section-B : 02 questions to be attempted having answers approximately in 250 words.
Section-C : 01 question to be attempted having answer in about 500 words.

SECTION A

Q.1(a)		1
(b)		1
(c)		1
(d)		1
(e)		1
	SECTION B	
Q.2		4
Q.3		4
Q.4		4
Q.5		4
	SECTION C	
Q.6		7
Q.7		7

(B) Semester or External Assessment:

70% weightage of Max. Marks (70 Marks out of 100 Max. Marks)

Duration of Examination: 3 Hours **Max. Marks: 70**

SECTION-A: 10x1=10
(Answer all questions)
(Two question from each unit with no internal choice)
Q. No. 1

(i) ……..…… **1 Mark**
(ii) ……..…… **1 Mark**
(iii) ……..…… **1 Mark**
(iv)……..…… **1 Mark**
(v)……..…… **1 Mark**
(vi)……..…… **1 Mark**

(vii)……..…… **1 Mark**
(viii)……..…… **1 Mark**
(ix)……..…… **1 Mark**
(x)……..…… **1 Mark**

SECTION-B: 5x5=25
(Answer all questions)
(One question from each unit with internal choice)
(Maximum two sub-divisions only)

Q. No. 2. . ……..……
Or
……..…….
5 Marks

Q. No. 3. ……..……
Or
……..……...
5 Marks

Q. No. 4. ……..……
Or
……..……
5 Marks

Q. No. 5. ……..……
Or
……..……...
5 Marks

Q. No. 6. ……..
Or
……..
5 Marks

SECTION-C: 1x15 + 2x10=35
(Answer any three questions including compulsory Q.No. 7)
(Maximum four sub-divisions only)

Q. No. 7. …… **15 Marks**

Q. No. 8. …… **10 Marks**

Q. No. 9. …… **10 Marks**

Q. No. 10. …… **10 Marks**

Q. No. 11. …… **10 Marks**

Distribution of Marks for Practical / Examinations:

Duration of Exam: 06 Hours **Maximum Marks: 100**

S. No.	Name of Exercise	Research Project Phase I			Research Project Phase II		
		Conti. Assess.	Sem. Assess.	Total Marks	Conti. Assess.	Sem. Assess.	Total Marks
2.	Dissertation	--	80	80	--	240	240
3.	Viva-voce	30	30	60	90	90	180
4.	Presentation	30	30	60	90	90	180
Total Marks		**60**	**140**	**200**	**180**	**420**	**600**

Rules regarding determination of results:

Each semester shall be regarded as a unit for working out the result of the candidates. The result of the each semester examination shall be worked out separately (even if he/she has appeared at the paper of the lower semester along with the papers of higher semester) in accordance with the following conditions:

a) The candidate shall be declared as pass in a semester examination, if he/she secures at least 40% marks in each theory paper separately in external & internal examination and 50% marks in each practical paper and at least 50 % marks in project/dissertation with 50% aggregate marks in that semester.
b) A candidate declared as fail/absent in one or more papers at any odd semester examination shall be permitted to take admission in the next higher semester (even semester) of the same academic session.
c) A candidate may be promoted in the next academic session (odd semester) if he/she has cleared collectively at least 50% of the papers of both semesters of previous academic session with 50% of the aggregate marks. The candidate who does not fulfill the above condition will remain as an ex-student and will reappear in the due papers along with next odd/even semester exams.
d) If any student who is provisionally admitted in higher odd semester but could not secure prescribed minimum marks in previous semesters will be treated as ex-student and his/her admission fee will be carry forwarded to the next odd semester of forthcoming academic session.
e) If a candidate, who is declared as pass, wishes to improve his/her performance in the theory papers of previous semester, he/she may re-appear only one time in these papers in next odd/even semester examinations.
f) Candidate shall not be permitted to re-appear or improve the marks obtained in the external examination of practical / dissertation in any condition.
g) If the number of papers prescribed in a semester examination is an odd number, it shall be increased by one for the purpose of reckoning 50% of the papers for considering the student pass/fail.
h) A candidate may be given only two additional chances for passing the semester thus maximum tenure for completing the two years' postgraduate course will be limited to four years, for three years postgraduate programme up to five years and so on.
i) The grace marks scheme shall be applicable as per University norms.

Classification of Successful Candidates:

The classification of successful candidates after last semester examination shall be as under:

Description of Marks Obtained	**Division / Result**
• 80% and above marks in a paper.	Distinction in that paper.
• A candidate who has secured aggregate 60% and above marks	First Division
• A candidate who has secured aggregate 50% and above but less than 60% marks	Second Division

Semester III

SOL 301: Modeling, Simulation and Decision Making

UNIT I

System, experiment, model, simulation - definition, importance and need of modeling and simulation, difference between modeling and simulation, difference between simulation and experiment, simulation application areas, advantages, disadvantages and difficulties in simulation, types of models.

UNIT II

Steps of modeling process-problem analysis, model formulation, model abstraction, defining variables, solving, execution, verifying, analysis of results. Verification and validation, comparison of model with real system, validity of model.

UNIT III

Solar energy modeling techniques, linear and non-linear modeling techniques, global solar energy model, discrete solar energy model, error and deviation, Thermal comfort models, ASHRAE 55 and Indian Model for Adaptive Thermal Comfort (IMAC), CARBSE tool.

UNIT IV

Brief introduction to the software used for simulation in solar energy field, comparative review of software for solar photovoltaics, solar thermal systems and buildings. Introduction to applications of PVSOL, PVSYST, HOMER, IES-VE, TRNSYS, SAM, SOLTRACE, METEONORM.

Unit V

Decision making- definition, need and importance, multi criteria decision making, Pugh method, Analytic Hierarchy Process (AHP), Kepner –Tregoe problem solving and decision making methods, selection of method, case studies.

REFERENCES

1. Bender E.A., “Introduction to Mathematical Modeling”, Dover Publ., 2000.

2. Meyer W.J., “Concepts of Mathematical Modeling”, Dover Publ.,2004.

3. Dym C.L., “Principles of Mathematical Modeling”, Elsevier, 2004.

4. Duffie J.A., Beckman W.A. “Solar Engineering of Thermal Process”,Wiley, 3rd ed. 2006.

5. Kalogirou S.A., “Solar Energy Engineering: Processes and Systems”,Academic Press, 2009.

6. Sen Z., Solar Energy “Fundamentals and Modeling Techniques”, Turkey, 2008.

7. Vanek F.M., Albright L.D. "Energy Systems Engineering", McGrawHill, 2008.

8. Tamer Khatib, Azah Mohamed, K. Sopian, "A review of solar energy modeling techniques" Renewable and Sustainable Energy Reviews 16 (2012) 2864– 2869

9. Multi-criteria analysis, Department for Communities and Local Government: London, 2009.

10. Burge Stuart, The Engineering toolbox, Pugh matrix, Strathclyde University, Glasgow, 2009.

SOL 302: Solar PV Power Plants

Unit I

Photovoltaic systems: Configuration and applications, grid –independent for small devices, PV systems for remote consumers of medium and large size, decentralized grid-connected PV systems, central grid connected PV systems. Components of PV systems-battery storage, charge controller, inverters, auxiliary generators, system sizing.

Unit II

Electrochemical storage: Fundamentals, types, parameters, comparison of batteries, selection of batteries, batteries for PV systems, connection of batteries, estimating requirement of batteries, battery bank installation and commissioning, diagnosis, testing, physical maintenance, safety measures.

Unit III

Balance of system-need, power converters, types and their efficiency, charge controllers, maximum power point tracking, wires, wire sizing, junction box, checklist, power conditioning for photovoltaic power systems, charge controller and charge equalizer, PV inverters, inverters for grid-connected and stand alone operation, power quality, active quality control in the grid, safety aspects with inverters.

Unit IV

Design methodology for SPV system, approximate design for standalone system, design of grid-connected SPV system, configuration, components, design for small power applications, grid-connected PV system design for power plants.

Unit V

Installation, troubleshooting and safety: Installation and troubleshooting of standalone SPV systems, electrical and mechanical safety in installation, safety with batteries, installation and troubleshooting of solar SPV power plants, solar PV plant installation checklist. Economic analysis.

1. Chetan Singh Solanki., Solar Photovoltaic: "Fundamentals, Technologies and Application", PHI Learning Pvt., Ltd., 2009.

2. Jha A.R., "Solar Cell Technology and Applications", CRC Press, 2010.

3. John R. Balfour, Michael L. Shaw, Sharlave Jarosek., "Introduction to Photovoltaics", Jones & Bartlett Publishers, Burlington, 2011.

4. Luque A. L. and Andreev V.M., "Concentrator Photovoltaic", Springer, 2007.

5. Partain L.D., Fraas L.M., "Solar Cells and Their Applications", 2nd ed., Wiley, 2010.

6. C. J. Winter, A. L. Sizmann, L. L. Hull, "Solar Power Plant" Springer-Verlag.

7. Antonio Luque and Steven Hegedus (Eds.), "Handbook of Photovoltaic Science and Engineering", Wiley.

8. Chetan Singh Solanki, "Solar Photovoltaic Technology and Systems.

SEMINARS

Objective: To assess the knowledge, expression and communication capability of the student to present a technical topic.

The aim of seminar is to impart training to a student to face audience and present his ideas and thus creating in him self esteem and courage that are essential for presentation of project proposals and reports. Individual students are required to choose a topic of their interest from Energy/Solar Energy/Hybrid Energy systems and give a seminar on that topic. A committee consisting of at least two faculty members shall assess the presentation of the seminar and award internal marks to the students. Each student shall submit two copies of a write up of this seminar topic. One copy shall be returned to the student after duly certifying it by the chairman of the assessing committee and the others will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation. At the semester end, the seminar report and presentation will be assessed by an external examiner.

SOL 303-Seminar (R&D)

Each student has to present six seminars on research and development during the semester. The aim of the seminar series is to equip the students with the knowledge about the research and developments in the field of energy studies and solar energy. Students have to prepare and deliver presentations on the research and development activities in the field of solar energy in India and abroad in various institutes, universities and research organisations. Further they have to give presentation on two research papers relevant to solar energy field.

SOL 304-Seminar (Industry-Society-Policies)

Each student has to present six seminars on developments in solar energy field linked to industry, society and the solar policies during the semester. The aim of the seminar series is to make students aware of the industrial developments and the challenges faced by industries in the solar energy field. They will learn to assess the potential of penetration of solar

technologies in society and their impact on socio-economic scenario. Knowledge of solar policies in India and worldwide is also important for people working in this field so it is also a component of the seminar series.

SOL 305-RESEARCH PROJECT PHASE I

Objective: The project work aims to develop the work practice in students to apply theoretical and practical tools/ techniques to solve real life problems related to industry, society and current research. The project work can be a design project/ experimental project and / or computer simulation project on any of the topics in the area of Energy/Solar energy/Hybrid energy systems. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least two faculty members. At semester end, one internal and one external expert will assess the report of the project on basis of presentation. The student is required to undertake the master research project phase 1 during the third semester and the same is continued in the 4th semester (Phase 2). Phase 1 consist of preliminary thesis work, reviews of the work and the submission of preliminary report. The review would highlight the topic, objectives, methodology, expected results and scope of the work which is to be completed in the 4^{th} semester.

SOL401-RESEARCH PROJECT PHASE II

Master Research project phase II is a continuation of project phase 1 started in the third semester. There would be one internal review at the end of the semester. The review would be a pre-submission presentation before the internal evaluation committee to assess the quality and quantum of the work done. This would be a pre qualifying exercise for the students for getting approval by the departmental committee for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be the external evaluation.