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 2024
Fourth Semester Examination, June 2025

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

Edition: 2024

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	Industrial Training			8	4	30	70	100	15	35	50
	3.4	SOL304	Research Project Phase I			24	12	90	210	300	45	105	150
	3.5	--	CBCS Paper		2		2	50	--	50	50	--	50
	Total				**10**	**32**	**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.

Programme and Course outcomes-

- Students will develop in-depth understanding of the principles of solar thermal and electrical energy systems.
- Students will gain expertise in the theoretical and practical aspects of solar energy conversion.
- Knowledge about detailed analysis of the different solar systems.
- Learners will know how to perform a technical survey of a system**.**
- Students will be trained in theory, experiments, modelling and simulation of solar systems.
- Skills related to presentation, project proposal preparation, project implementation and research paper writing will be developed.
- Learner will understand the basic requirements for the installation of any solar system and selection of the system components.
- Understanding related to undertaking research problem and offering solutions from technical, environmental, economic and societal perspectives will be enhanced.

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/Electronics/Materials Science/Nanotechnology), 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 four contact hours per week for laboratory or practical work shall be equal to two credits per week and carry 25 maximum marks and therefore, sixteen teaching hours per week shall carry 100 maximum marks for laboratory or practical work.

Assessment Pattern:

The assessment of the students shall be divided into two parts in which first part is continuous or mid-term or internal assessment (30% weightage of the maximum marks) and second part is semester or end-term or external assessment (70% weightage of the maximum marks).

(i) Continuous / Mid-Term / Internal Assessment:

(a) The continuous or mid-term or internal assessment for each theory paper shall be taken by the faculty members in the Department during each semester. Internal assessment part is further divided in two parts of equal weightage of marks as per the details given below:

Continuous Assessment	**Modes of Assessments**		**Max. Marks**
	Collegiate (Regular) Students	**Non-collegiate (Private) Students**	
Cont. Assess-I	Written Examination	Report Writing	20
Cont. Assess-II	Seminar / Presentation / Project Report / Quiz / GD / Viva-voce	Viva-voce	10

Note: *In the Continuous/Mid-Term/Internal Assessment-I, written examination shall be of one hour duration for each theory paper and shall be taken according to the academic calendar which will be notified by the Department. Time duration for Continuous/Mid-Term/Internal Assessment-II is not allotted. It will be decided by the faculty member which will be taking second internal assessment.*

(b) For practical papers, there will not be continuous or mid-term or internal assessment. There will be only one external or end-term or semester assessment having 100% weightage of maximum marks.

(c) A student, who remains absent (defaulter) or fails or wants to improve the marks in the continuous or mid-term or internal assessment, may be permitted to appear in the desired paper(s) in same semester and one time only with the permission of the concern Head of the Department. Defaulter/improvement fee

of Rupees 250/- per paper shall be taken from such candidates. Duly forwarded application of such student by the Head of the Department, who may permit the such candidates to appear in the continuous or mid-term or internal assessment after production of satisfactory evidence about the reason of his/her absence in the test(s) and deposition of the defaulter/improvement fee, shall be sent to the concerned teacher to take the continuous or mid-term or internal assessment of such candidates. A record of such candidates shall be kept in the Department.

(d) Regular attendance of the student shall be considered in the internal assessment. Marks (equal to 10% of internal assessment) may be given to the student(s) for regularity who is/are taken classes regularly. If the attendance/regularity factor is similar for all the students, then weightage marks for regularity may be merged in the weightage of second internal assessment (seminar / presentation / assignment / dissertation / quiz / group discussion / viva-voce, *etc.*).

(e) Paper wise consolidated marks for each theory paper and dissertation / seminar (*i.e.* total marks obtained during various modes of internal assessment) obtained by the students (out of the 30% weightage of the maximum marks of the each paper) shall be forwarded by the Head of the Department (in two copies) to the Controller of Examinations of the University within a week from the date of last internal assessment test for incorporation in the tabulation register.

(f) The consolidated marks obtained by the students be also made known to them before being communicated by the concerned Head of the Department to the University for final incorporation in the tabulation register. If any discrepancies are discovered or pointed out by the students, the same shall be looked into by the concerned faculty member and corrections made, wherever necessary. The decision of the Head of the Department before the communication of marks to the University shall be final. No corrections shall be made in the internal assessment marks after the declaration of the result by the University.

(g) Consolidated marks of internal assessment obtained out of the 30% weightage of maximum marks of each theory paper which will be communicated to the University shall be in whole number and not in fraction. Marks awarded for the various internal assessments in each paper shall be added up and then round off to the next whole number to avoid any fraction.

(h) All test copies and other material related to the internal assessment shall also be sent to the Controller of Examinations of the University to keep in record as per the University guidelines.

(i) The concerned Head of the Department shall be responsible for proper conduct of internal assessment tests and for communication of the consolidated marks to the University within the prescribed time.

(j) The Head of the Department shall keep a record of the marks and also notify the same to the candidates immediately so that if any candidate is not satisfied with the award in any test or seasonal work, he / she should represent the matter to the higher authority.

(ii) Semester / End-Term / External Assessment:

(a) The semester or end-term or external assessment (70% weightage of the maximum marks) shall be 03 hours duration to each theory paper and 06 hours duration for each practical paper and shall be taken by the University at the end of each semester.

(b) The syllabus for each theory paper is divided into five independent units.

Question Paper Pattern:

(A) Continuous / Mid-Term / Internal Assessment:

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

(i) Continuous / Mid-Term / Internal Assessment-I (Max. Marks: 20):

Department of .....
University / College : .....
Address .....

First Internal Assessment Test 20… - 20….
(Written Examination)

Name of Class/Course :	Max. Marks : 20 Marks
Name of Semester :	Duration of Exam. : 1.00 Hr
No. & Name of Paper :	Date of Exam. :

Q. No. 1. …… 05 Marks
or
……

Q. No. 2. …… 05 Marks
or
……

Q. No. 3. …… 05 Marks
or
……

Q. No. 4. …… 05 Marks
or
……

(ii) Continuous / Mid-Term / Internal Assessment-II (Max. Marks: 10):

Department of .....
University / College: .....
Address .....

Second Internal Assessment Test 20… - 20….
(Seminar / Presentation / Project Report / Quiz / GD / Viva-voce)

Name of Class/Course:	Max. Marks : 10 Marks
Name of Semester :	Mode of Assessment:
No. & Name of Paper:	Date of Assessment:

Format for Compilation of Marks/Awards of
Continuous/Mid-Term/Internal Assessment-I & II

Department of .....
University / College: .....
Address .....

Name of Class/Course: .....
Name of Semester : .....
No. & Name of Paper: .....
Max. Marks : .....

S. No.	Name of Student	Father's Name	Marks Obtained			
			Internal Assess. - I	Internal Assess. - II	Total Marks (In Figure)	Total Marks (In Words)
1.						

Name & Signature of the Faculty Member

(B) Semester / End-Term / External / Assessment:

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

Question Paper Pattern for Semester Examination

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

Note: *The syllabus is divided into five independent units and question paper will be divided into following two sections:*

- ***Section-A*** *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*
- ***Section-B*** *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Section-A

Q. No. 1: Comprising 10 Short Answer Type Questions

Unit-I

(i) …… 02 Marks
(ii) …… 02 Marks

Unit-II

(iii) …… 02 Marks
(iv) …… 02 Marks

Unit-III

(v) …… 02 Marks
(vi) …… 02 Marks

Unit-IV

(vii) …… 02 Marks
(viii) …… 02 Marks

Unit-V

(ix) …… 02 Marks
(x) …… 02 Marks

Section-B

Unit-I

Q. No. 2: …….. 10 Marks

Or

……

Unit-II

Q. No. 3: …….. 10 Marks

Or

……

Unit-III

Q. No. 4: …….. 10 Marks

Or

……

Unit-IV

Q. No. 5: …….. 10 Marks

Or

……

Unit-V

Q. No. 6: …….. 10 Marks

Or

……

Practical Examinations:

S. No.	Name of Exercise	Industrial Training			Research Project Phase I			Research Project Phase II		
		Conti. Assess.	Sem. Assess.	Total Marks	Conti. Assess.	Sem. Assess.	Total Marks	Conti. Assess.	Sem. Assess.	Total Marks
2.	Dissertation/Report	--	40	40	--	120	120	--	240	240
3.	Viva-voce	15	15	30	45	45	90	90	90	180
4.	Presentation	15	15	30	45	45	90	90	90	180
Total Marks		**30**	**70**	**100**	**90**	**210**	**300**	**180**	**420**	**600**

Minimum Pass Marks and Rules regarding Determination of Results:

Each semester shall be regarded as a unit for working out the result of the candidates. The result of 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 continuous/internal and semester /

external examinations and 50% marks in each practical paper/project/dissertation with 40% 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. The candidate who does not fulfill the above condition will remain as an ex-student and will re-appear in the due papers' examinations along with next odd/even semester examinations.

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, wants to improve his/her performance in the theory papers of just previous semester, he/she may re-appear only one time in these theory 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 for three years undergraduate programme up to five years and so on.

i) The grace marks scheme shall be applicable as per the 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
• 75% 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
• A candidate who has secured aggregate 40% and above but less than 50% marks	Pass

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.

SOL 303 Industrial Training

The objective of the industrial/field training is to expose the students to the real life and field based works in the areas relevant to solar energy. The purpose of undertaking industrial training is to provide work experience so that student's engineering knowledge is enhanced and employment prospects are improved. Industrial training of the students is essential to bridge the wide gap between the classroom and industrial environment. This will enrich their practical learning and they will be better equipped to integrate the practical experiences with the classroom learning process. Students shall be given option to select the industries or agencies depending upon their choice. The field/industrial training shall be of total duration of 120 hours. The evaluation shall be on the basis of report and seminar presentation of the industrial training. 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 the report. 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 work done, presentation skill, quality of the report and participation. At the semester end, the training report and presentation will be assessed by an external examiner.

SOL 304-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 semester IV (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 semester IV.

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 dissertation/report. 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/report. The final evaluation of the project will be the external evaluation.