UNIVERSITY OF KOTA

SCHEME OF EXAMINATION

AND

COURSES OF STUDY

Department of Pure & Applied Physics
Faculty of Science

M.Tech. (Solar Energy)

Third Semester (July-December, 2015)
Fourth Semester (January-May, 2016)

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

Edition: 2015

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 IIISemester	3.1	SOL301	Solar Buildings	3 Hrs	4		4	20	80	100	07	29	36
	3.2	SOL302	Solar PV Power Plants	3 Hrs	4		4	20	80	100	07	29	36
	3.3	SOL 303	Seminar		4		4	20	80	100	08	32	40
	3.4	SOL304	Research Project Phase I		16		12	60	240	300	24	96	120
	Total						**24**	**120**	**480**	**600**			
II Year IV Semester	4.1	SOL401	Research Project Phase II		32		24	120	480	600	48	192	240
							24			**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- 50%.

- The admission shall be through Merit and Written test. 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:

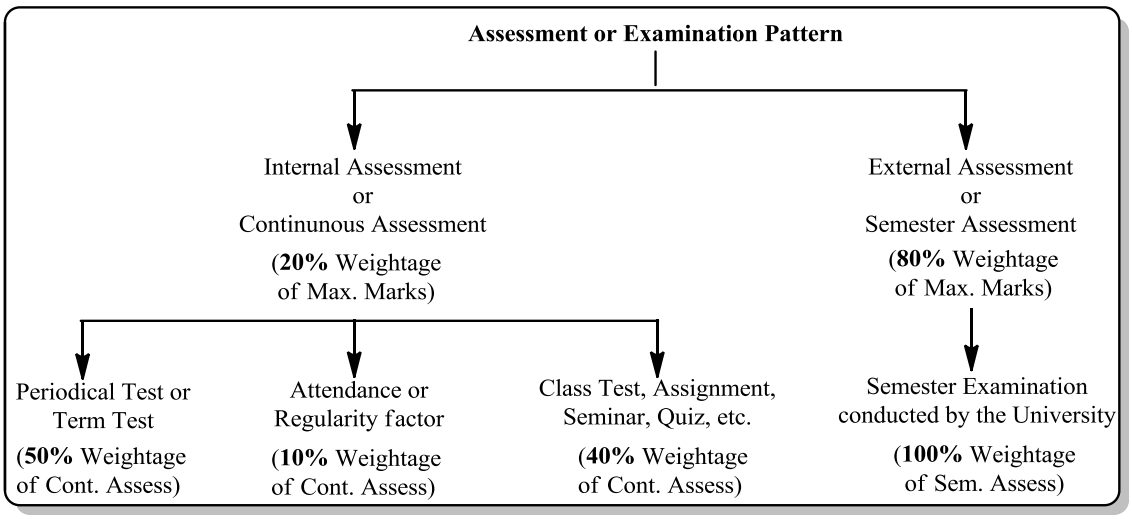
The classroom teaching would be through conventional lectures or power point presentations (PPT). The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skills. 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 per week. One teaching hour per week shall carry 25 maximum marks and therefore, four teaching hours 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 contact hours per week for theory paper, therefore, for 16 contact hours per week for practical work shall be equal to 08 contact hours per week for theory paper and shall carry 100 maximum marks.

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 continuous assessment for each theory paper shall be taken by the faculty members in the Department. Two periodical tests or term tests for internal assessment shall be of one hour duration and shall be taken according to academic calendar which shall be notified by the Department/University. The semester assessment shall be three hours duration to each theory paper and six hours duration to each practical paper and shall be taken by the University at the end of each semester. Assessment pattern and distribution of maximum marks is summarized as given below:



The evaluation of the seminar shall be based on the internal assessment process only. A student cannot repeat the assessment of periodical test or term test. However, if for any compulsive reason the student could not attend the test, other tool for assessment may be framed by the teacher in consultation with the Head of the Department. If the regularity factor is similar for all the students in that case it may be merged with the term test weightage.

Question Paper Pattern:

(A) Internal Assessment:

20% weightage of Maximum Marks (20 Marks out of 100 Maximum Marks)

For internal assessment examinations the scheme shall be followed as:

Section A: One compulsory question will have four parts of 0.5 marks each i.e. total marks 2 with word limit 20 words for each part.

Section-B: Two questions with internal choice with descriptive answer type of 4 marks each. (max. two questions)

Periodical Test / Term Test Format

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

Duration of Exam: 1½ Hr **Max. Marks: 10**
Class: M.Tech. (Solar Energy) **Semester:**
Subject: **Paper:**
No. of Students: **Teacher:**

Note: The question paper contains two sections as under:
Section A: One compulsory question will have four parts of 0.5 marks each i.e. total marks 2 with word limit 20 words for each part.
Section-B: Two questions with internal choice with descriptive answer type of 4 marks each. (max. two questions)

SECTION A

Q.1(a)		½
(b)		½
(c)		½
(d)		½
	SECTION B	
Q.2		4
	OR	
Q.3		4
Q.4		4
	OR	
Q.5		4

(B) External Assessment

80% weightage of Maximum Marks (80 Marks out of 100 Maximum Marks)

All the question papers of M.Tech. (Solar Energy) semester scheme shall contain two sections as under:

Section-A : One compulsory question with eight parts of 16 marks in total, having 2 parts from each unit, of short answer in 20 words for each part of 2.0 marks each.

Section-B : There shall be two questions from each unit (total units four) with internal choice with descriptive answer type of 16 marks each. The students will have to attempt one question from each unit.

Duration of Examination: 3 Hours **Max. Marks: 80**

Note: The syllabus is divided into four units and question paper will be divided into two sections. Section-A will carry 16 marks with one compulsory question of equally divided 8(eight) short answer type questions (about 20 words) and examiners are advised to set two short questions from each unit. Section-B shall be of two questions from each unit (total units four) with internal choice with descriptive answer type of 16 marks each. The students will have to attempt one question from each unit

External Examination Format

SECTION-A: 8 x2=16
(Answer all questions)
(Two question from each unit with no internal choice)
Q. No. 1

(i) ……..…… **2 Mark**
(ii) ……..…… **2 Mark**
(iii) ……..…… **2 Mark**
(iv)……..…… **2 Mark**
(v)……..…… **2 Mark**
(vi)……..…… **2 Mark**
(vii)……..…… **2 Mark**
(viii)……..…… **2 Mark**

SECTION-B: 4 x 16=64
(Answer one question from each unit with internal choice)

Q. No. 2. . ……..……

……..…… **16 Marks**

Or

Q. No. 3. ……..……

……..…….... **16 Marks**

Q. No. 4. ……..……

……..…… **16 Marks**

Or

Q. No. 5. ……..……

……..……..... **16 Marks**

Q. No. 6. …….....

……..... **16 Marks**

Or

Q. No. 7. ……..……

……..…… **16 Marks**

Q. No. 8. ……..……

……..……..... **16 Marks**

Or

Q. No. 9. …….....

……..... **16 Marks**

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 to have passed the examination if he/she secures minimum 36% marks in each theory (internal and external separately) paper(s) prescribed for the semester.
(b) For the practical, project work and seminar, a candidate should secure at least 40% marks in internal and external separately.
(c) A student must secure at least 40% marks in the aggregate of the internal and external components of the theory papers individually prescribed for the semester.
(d) A candidate who does not fulfil either of the aforesaid conditions i.e. (a)-(c) shall be declared as failed in that particular paper, which he/she can reappear in the next year examination as a due paper. However, the internal marks shall be carried forward for the total marks of the due examination.
(e) If a candidate fails in the internal assessment, he/she shall be declared failed in that paper(s) of odd/even semester. In such a case he/she shall reappear in the same paper as due paper in odd/even semester examination of next year and for the marks obtained by him/her out of external component shall be raised proportionally to the marks out of total marks for working out the results.
(f) A candidate failing or absenting in one or more theory paper(s) as well as also in practical, project work at a semester examination shall be permitted to join the courses of study for the next higher even semester i.e. IV semester and eligible to re-appear in that paper(s) in next year examination.
(g) A candidate for a semester examination shall be offered all the papers prescribed for that semester examination and in addition he/she shall be required to take due papers of any lower semester examination(s) provided that the number of chances to clear theory, practical, project work paper shall be limited to two only.
(h) If a student who has been promoted to the next semester wishes to improve his/her performance can be permitted to do so in case of the theory papers only belonging to the immediately preceding semester. In such a case he/she shall have to appear in these papers along with the papers of his/her own semester.
(i) The grace marks scheme shall be applicable as per University norms.

Classification of Successful Candidates:

Candidates who secure 60% of the aggregate marks in the whole examination shall be declared to have passed the examination in First Division. Candidates who secure 50% marks or more but less than 60% of the aggregate marks in whole examination shall be declared to have passed the examination in Second Division. Candidates who secure 40% marks or more but less than 50% of the aggregate marks in whole examination shall be declared as pass.

Candidates who obtain 75% of the marks in the aggregate shall be deemed to have passed the examination in First Division with Distinction provided they pass all the examinations prescribed for the course at the first appearance. Candidates who pass all the examinations prescribed for the course in the first instance and within a period three academic years from the year of admission to the course only are eligible for University Ranking. A candidate is deemed to have secured first rank provided he/she

(i) Should have passed all the papers in first attempt itself.
(ii) Should have secured the highest marks.

Semester III

SOL 301: Solar Buildings

Unit I

Thermal comfort, factors affecting thermal comfort, comfort parameters, Climatic conditions, climate zone, classification of climate zones, heat flow calculations in buildings: Unsteady heat flows through walls, roof, windows etc. Building loss coefficients, building energy storage capacity, direct heat gains through windows. Convective gains/losses, air exchange rates, Gains from people, appliances etc. Air conditioning load calculations, estimation of heating, cooling and lighting requirements, building orientation, building conditions.

Unit II

Building heating and cooling- active methods, solar heating systems- liquid and air systems, heating system parametric study, solar energy- heat pump systems, phase change and seasonal storage systems, solar and off-peak storage systems, solar air-conditioning, passive and hybrid methods, concepts of passive heating and cooling, insulation, shading, sunspace, storage walls and roofs, ventilation, evaporative and nocturnal cooling, earth–air tunnel, solar chimney, active collection-passive storage hybrid systems, heat distribution in passive buildings, passive applications.

Unit III

Design of passive and hybrid systems- approaches to passive design, the solar –load ratio method, unutilizability design method- direct gain and collector storage walls, hybrid systems, energy efficient buildings, overview of softwares packages commonly used in energy-efficient building analysis and design.

Unit IV

Energy conservation building code: Purpose and scope, administration and enforcement, building envelope, heating ventilation and air-conditioning, service water heating and pumping, lighting, electrical power, whole building performance assessment, Building integrated photovoltaic systems.

REFERENCE BOOKS

1) Duffie J.A., Beckman W.A. "Solar Engineering of Thermal Process",Wiley, 3rd ed. 2006.
2) Garg H.P., Prakash J., "Solar Energy Fundamentals and Applications", Tata McGraw-Hill, 2005.
3)Yannas S., Erell E., Molina J., Roof Cooling Techniques: Design Handbook, Earthscan, 2006.
4) K.Sukhatme, Suhas P.Sukhatme., "Solar energy: Principles of thermal collection and storage", Tata McGraw Hill publishing Co. Ltd, 8th edition, 2008.
5) Energy Simulation in Building Design – J A Clarke, Butterworth-Heinemann, Oxford.
6) Renewable Energy: M. Kaltschmit, W. Streicher, A. Wiese, Springer 2007.
7) Antonio Luque and Steven Hegedus (Eds.), "Handbook of Photovoltaic Science and Engineering", Wiley.
8) Energy Conservation Building Code- User Guide, USAID-India, 2009.
9) Energy-efficient buildings in India,,, Mili Majumdar (Ed.), TERI-MNRE, 2002.

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. 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.

REFERENCE BOOKS

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.

SOL303: SEMINAR

Objective: To assess the communication capability of the student to present a technical topic. Also 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 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 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.

Semester IV

SOL 401: RESEARCH PROJECT PHASE II

Master Research project phase II is a continuation of project phase 1 started in the third semester. There would be two internal reviews in the fourth semester, first in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work, presentation and discussion. Second 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.