

P.G.Diploma in Non Conventional  
Energy System

Prospectus No. 20111245

संत गाडगे बाबा अमरावती विद्यापीठ  
SANT GADGE BABA AMRAVATI UNIVERSITY

विज्ञान विद्याशाखा  
(FACULTY OF SCIENCE)

**PROSPECTUS**  
OF  
The Examination for the Post Graduate Diploma in  
Non Conventional Energy System (One Year)  
Semester-I, Winter-2010  
Semester-II, Summer-2011



2010

Price Rs...../-

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## I N D E X

### Post Graduate Diploma in Non Conventional Energy System (One Year) (Semester-I & II)

(Prospectus No.20111245)

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**SANT GADGE BABA AMRAVATI UNIVERSITY  
SPECIAL NOTE FOR INFORMATION OF THE STUDENTS**

- (1) Notwithstanding anything to the contrary, it is notified for general information and guidance of all concerned that a person, who has passed the qualifying examination and is eligible for admission only to the corresponding next higher examination as an ex-student or an external candidate, shall be examined in accordance with the syllabus of such next higher examination in force at the time of such examination in such subjects, papers or combination of papers in which students from University Departments or Colleges are to be examined by the University.
- (2) Be it known to all the students desirous to take examination/s for which this prospectus has been prescribed should, if found necessary for any other information regarding examinations etc. refer the University OrdinanceBooklet the various conditions/provisions pertaining to examinations as prescribed in the following Ordinances-

(3)

- Ordinance No. 1 : Enrolment of Students.  
Ordinance No. 2 : Admission of Students  
Ordinance No. 4 : National Cadet Corps  
Ordinance No. 6 : Examination in General (relevant extracts)  
Ordinance No. 18/2001 : An Ordinance to provide grace marks for passing in a Head of passing and Improvement of Division (Higher Class) and getting Distinction in the subject and condonation of defficiency of marks in a subject in all the faculties prescribed by the Statute NO.18, Ordinance 2001.  
Ordinance No.9 : Conduct of Examinations (Relevant extracts)  
Ordinance No.10 : Providing for Exemptions and Compartments  
Ordinance No. 19 : Admission Candidates to Degrees  
Ordinance No.109 : Recording of a change of name of a University Student in the records of the University  
Ordinance No.6 of 2008 : For improvement of Division/Grade.  
Ordinance No.19/2001 : An Ordinance for Central Assessment Programme, Scheme of Evaluation and Moderation of answerbooks and preparation of results of the examinations, conducted by the University, Ordinance 2001.

**Dineshkumar Joshi**  
Registrar  
Sant Gadge Baba Amravati University

**PATTERN OF QUESTION PAPER ON THE UNIT SYSTEM**

The pattern of question paper as per unit system will be boradly based on the following pattern.

- (1) Syllabus has been divided into units equal to the number of question to be answered in the paper. On each unit there will be a question either a long answer type or a short answer type.
- (2) Number of question will be in accordance with the unit prescribed in the syllabi for each paper i.e. there will be one question on each unit.
- (3) For every question long answer type or short answer type there will be an alternative choice from the same unit. However, there will be no internal choice in a question.
- (4) Division of marks between long answer and short answer type question will be in the ratio of 40 and 60.
- (5) Each short answer type question shall Contain 4 to 8 short sub question with no internal choice.

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**SANG GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI**

**DIRECTION**

No. : 54 of 2010

Date : 18 / 09 / 2010

**Subject : Examination leading to One Year Post Graduate Diploma course in Non Conventional Energy System Direction, 2010.**

Whereas, University Grants Commission, New Delhi, vide its letter No.F.14-8/2008 (Inno/ASIST.), dated 30th March, 2009 has granted approval and sanction for release of grants-in-aid to the Gulam Nabi Azad Arts, Commerce & Science College, Barshitakli for P.G.Diploma (One Year) in Non Conventional Energy System under Innovative Programme - Teaching & Research in Interdisciplinary & Emerging areas.

AND

Whereas, Government of Maharashtra vide its letter क्र.एनजीसी २००८ (१७७/७८)/ मशि-३, दि. ३१ जुलै, २००८ has sanctioned approval for starting of One Year Post Graduate Diploma course in Non Conventional Energy System to the above college.

AND

Whereas, Academic Council in its meeting held on 27.8.2010 vide item No.88 has approved Draft Syllabi, Scheme of Examination and Provisions to be incorporated in the Ordinance for One Year Post Graduate Diploma course in Non Conventional Energy System.

AND

Whereas, Scheme of examination of above said course is to be implemented from the Academic Session 2010-11 for Semester-I & onwards which is regulated by an Ordinance.

AND

Whereas, framing of an Ordinance is likely to take some time.

AND

Whereas, the admission to students in the above course are to be made in the Academic Session 2010-11.

Now, therefore, I, Dr.Kamal Singh, Vice-Chancellor of Sant Gadge Baba Amravati University, Amravati in exercise of powers conferred upon me under sub-section (8) of section 14 of the Maharashtra Universities Act, 1994, do hereby directs as under:-

- 1) This Direction may be called, " Examination leading to One Year Post Graduate Diploma course in Non Conventional Energy System Direction, 2010".
- 2) This Direction shall come into force w.e.f. the date of its issuance.
- 3) Following shall be the Examinations leading to the-
  - (i) Post Graduate Diploma in Non Conventional Energy System, Semester-I - Examination
  - (ii) Post Graduate Diploma in Non Conventional Energy System, Semester-II - Examination
- 4) Duration of each of the above semester shall be six months with an examination at the end of each semester.
- 5)
  - (i) The examinations specified in paragraph 3 above shall be held twice a year at such places and on such dates as may be appointed by the Board of Examinations.
  - (ii) Main Examination of Semester-I shall be held in Winter and Supplementary Examination in Summer.
  - (iii) Main Examination of Semester-II shall be held in Summer and Supplementary Examination in Winter.
- 6) Subject to his/her compliance with the provisions of this Direction and of other Ordinances in force from time to time, the following candidates shall be eligible for admission to the Post-Graduate Diploma in Non Conventional Energy System [Semester Pattern.....One Year (Full Time) P.G. Diploma Course] Examinations namely:-  
Bachelor Degree in any discipline of Science subjects or B.Sc. (Agri.)
- 7) Subject to his/her compliance with the provisions of this Direction and of other Ordinances (Pertaining to examination in General) in force from time to time, the applicant for admission to examination at the end of the course of study of a particular Semester shall be eligible to appear at it, if:
  - (i) he/she satisfied the conditions in the table and the provisions thereunder :-

**TABLE**

Sr.No.	Name of examination	The student should have completed the term satisfactorily	The student should have passed following examination
1	2	3	4
1	Diploma in Non Conventional Energy System Semester-I	Semester-I	As indicated in Para 6.
2	Diploma in Non Conventional Energy System Semester-II	Semester-II	-----

- (Note –(i) Subjects prescribed and numbered in the scheme of Examinations shall be treated as separate subjects, however, the theory and practical, if any, of the subject shall be treated as separate Head of Passing.  
(ii) He/She has complied with provisions of Ordinance pertaining to Examination in general.  
(iii) He/She has prosecuted a regular course of study in University Department/College affiliated to the University.  
(iv) He/She has in the opinion of the Head of the Department/Principal, shown satisfactory progress in his/her studies.)
- 8) Papers and the Practicals in 'which an examinee is to be examined, maximum marks for these and the minimum pass mark which an examinee must obtain in order to pass in the subject and the examination are detailed in the Examination Scheme appended herewith as Appendix-A with this Direction.
- 9) Examination fees for each semester of the examination and also the practical examination shall be as prescribed by the University from time to time.
- 10) An examinee who is successful at Semester-I, Semester-II examinations under this Direction and who obtained 75% or more marks in aggregate of Semester-I, Semester-II Examinations shall be placed in the First Division with Distinction, those obtaining 60% or more but less than 75% shall be placed in the First Division and all other successful examinees shall be placed in the Second Division.
- 11) (i) Scope of the subjects shall be as indicated in the syllabus.  
(ii) Medium of instruction and examination shall be English.
- 12) Provision of Ordinance No.18 of 2001 relating to an Ordinance to provide grace marks for passing in a head of passing and Improvement of Division (Higher Class) and getting distinction in the subject and condonation of deficiency of marks in a subject in all the faculties prescribed by the Statute No.18 and of Ordinance No.10 relating to Providing for Exemptions and Compartments shall apply to the examination under this Direction.
- 13) An examinee who does not pass or who fails to present himself/herself for the examination shall be eligible for readmission to the same examination on payment of fresh fees and such other fees as may be prescribed.
- 14) As soon as possible after the examination, the Board of Examinations shall publish a result of the examinees. The result of the examinations shall be classified as above and merit list shall be notified as per Ordinance No. 6
- 15) Notwithstanding anything to the contrary in this Direction no one shall be admitted to an examination under this Direction, if he/she has already passed the same examination or an equivalent examination of any Statutory University.
- 16) Examinees who have passed in all the subject prescribed for Semester-I, Semester-II of the examination of the Diploma course shall be eligible for award of the Post-Graduate Diploma in Non Conventional Energy System [Semester Pattern.....One Year (Full Time) P.G. Diploma Course].

Amravati  
Date : 17/9/2010

Sd/-  
(Dr.Kamal Singh)  
Vice-Chancellor

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**Appendix-A**  
**Scheme of Teaching and examination for the Post Graduate Diploma in Non -Conventional Energy Sources (One Year - Semester Pattern)**

Sr. No.	Sub. Code No.	Paper/ Practical No.	Subject	Teaching Scheme			Examination Scheme										Grand Total
				Theory	Practical	Total Periods/ week	Theory					Practical					
							Duration of Papers (Hrs.)	Max. Marks Theory Papers	Max. Marks Internal Assessment	Total	Min. Pass Marks	Max. Marks	Max. Marks Internal Assessment	Total	Min. Pass Marks		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	
<b>Semester-I</b>																	
1	1NCES1	I	Introduction to Non-conventional Energy System	4	-	4	3	40	10	50	20	--	--	--	--	50	
2	1NCES2	II	Solar Thermal Energy	4	-	4	3	40	10	50	20	--	--	--	--	50	
3	1NCES3	III	Photovoltaic Effect and its applications	4	-	4	3	40	10	50	20	--	--	--	--	50	
4	1NCES4	IV	Wind Energy, Nuclear Energy and Magneto Hydro Dynamic Power	4	-	4	3	40	10	50	20	--	--	--	--	50	
5	1NCES5	P-I	Practical I - LAB I	-	6	6	--	--	--	--	--	40	10	50	20	50	
6	1NCES6	P-II	Practical II - LAB II	-	6	6	--	--	--	--	--	40	10	50	20	50	
			Total	16	12	28			200					100		300	
<b>Semester-II</b>																	
1	2NCES1	V	Geo-Thermal Energy, Tidal Energy and Thermoelectric Power	4	-	4	3	40	10	50	20	--	--	--	--	50	
2	2NCES2	VI	Bio-mass and Bio-gas Technology	4	-	4	3	40	10	50	20	--	--	--	--	50	
3	2NCES3	VII	Introduction to Material Science and Characterization	4	-	4	3	40	10	50	20	--	--	--	--	50	
4	2NCES4	VIII	Economics of Energy management Energy Policy	4	-	4	3	40	10	50	20	--	--	--	--	50	
5	2NCES5	P-III	Practical - III LAB - 3	-	6	6	--	--	--	--	--	40	10	50	20	50	
6	2NCES6	P-IV	Project	-	6	6	--	--	--	--	--	--	--	50	20	50	
			Total	16	12	28								100		300	
													Grand Total of Semester-I & II				600

**Syllabi for Post Graduate Diploma in Non Conventional Energy Systems**

**SEMESTER-I**

**Paper – I (NCES1)**  
***(Introduction to Non-conventional Energy System)***

- Unit-I : Energy scenario in India, energy requirements and development of society, Depletion of energy sources, rise in energy consumption, Use of non-conventional energy sources and energy security
- Unit-II : Introduction to non conventional energy system, traditional energy sources, fossil fuel base system, impact of fossil fuel base system, need of non- conventional and renewable energy sources and their features. Hybrid energy systems.
- Unit-III : Environmental impact of conventional energy system: effect of conventional energy consumption on degradation of environment due to energy production and utilization, primary and secondary pollution: air, thermal and water pollution. Depletion of ozone layer, global warming; biological damage due to degradation of environment.
- Unit-IV : Fundamentals of electricity: concepts of different electric parameters like voltage current, electric power and energy, conversion of thermal, chemical, electromagnetic and mechanical energy in to electricity. Energy Conservation: Principle of conservation of energy, History of energy uses. Unit of energy consumption. Energy conservation technology (thermal energy), sources of waste heat and its potential application, heat recovery systems: heat exchanger.
- Unit-V : Chemical energy sources, fuel cell : Introduction and design and principle of fuel cell with special reference to H<sub>2</sub>-O<sub>2</sub> cells. Types of fuel cells; their advantages and disadvantages; efficiency and applications. Batteries: introduction, definitions of fundamental quantities types of batteries, classification and advantages.

**Paper - II (NCES2)**  
***(Solar Thermal Energy)***

- UNIT-I : Heat and Thermodynamics: Basic Units, Dimensions and Conversions For Energy, Concepts of Energy, Heat and Work, Ideal gas law, Ist and II law of thermodynamics (Closed and Open Systems). Thermodynamics power cycles, Reversible heat Engine cycle, I.C. engine cycles, Carnot Cycle.
- UNIT-II: Basic ideas of Black body radiation, solar radiation and solar radiation data. Extra-terrestrial and terrestrial radiations, instruments to measure solar radiations. Solar constant , Empirical relation for predicting the availability of solar radiation, estimation of average solar radiation, Seasonal and daily variation.
- UNIT-III: Solar Thermal Energy: Introduction to solar collectors: ( Liquid Flat Plate collector, Air heater and Concentrating collector) Glazing, evacuation, selective surfaces. Thermal energy storage: Introduction, sensible heat storage, latent heat storage, thermo chemical storage.
- UNIT-IV: Solar Thermal Energy Applications-I: Solar water heating system, heat exchangers and heat collector; Solar air heater introduction; performances analysis of conventional air heater; concentrating collector, parabolic collector, collector efficiency and collector heat removal factor.
- UNIT-V: Solar Thermal Energy Applications-II: Industrial hot water system, low pressure steam generation, solar distillation, solar drying, use of solar thermal systems with existing systems, example of hybrid system. Introduction to integrated solar thermal systems

**Paper – III (NCES3)**  
***(Photovoltaic Effect and its applications)***

- UNIT-I : Photovoltaic Effect.: Properties of Semiconductor, p-n junction, characteristics, types of polycrystalline silicon, amorphous silicon, GaAs and tanden cell, Introduction to single- junction and multi-junction films.
- UNIT-II : Solar Photovoltaic Conversion: Basic principle of SPV conversion, types of SPV cells characteristics of SPV cell, Solar cell operation, efficiency limits. Effect of temperature, insulation and tilt angle on the performance of SPV cell.
- UNIT-III : Solar Photovoltaic Systems: Modules and arrays, simple photovoltaic systems series and parallel connections, photovoltaic hybrid system, photovoltaic thermal system. Storage battery; solar chargeable battery, Understanding the design and maintenance of battery storage.
- UNIT-IV : PV Applications and Devices: Introduction of Solar Street light system, Solar water pumps, solar fan, determining the available solar resource and conducting site assessments for PV installations, Planning and preparing for PV system installations,



UNIT-V: Implementing mechanical designs for PV systems that meet the performance, architectural and structural requirements for given applications , Implementing electrical designs for PV systems that meet the safety, code-compliance and functional requirements for given applications Conducting acceptance tests and inspections, and commissioning PV system installations, Evaluating, troubleshooting, and maintaining PV systems.

**Paper -IV (1NCES4)**

***(Wind Energy, Nuclear Energy and Magneto Hydro Dynamic Power)***

- Unit-I : Basic principles: The nature of wind, its structure, statistics, measurement and data presentation, seasonal variation of wind velocity; Wind pattern in India , Maharashtra and in Vidharabha. Site selection considerations
- Unit-II : Power in wind, forces on blades, wind energy conversion system(WECS), components of WECS, Classification of WECS. Wind turbine, Aerodynamics: Momentum theory, basic aerodynamics airfoils and their characteristics.
- Unit-III : Types of wind machines, HAWT : blade element theory, Prandtl's lifting Line theory, VAWT: Aerodynamics, wind turbine loads, Aerodynamics loads in steady operation, Wind Turbulence, Yawed operation and tower shadow
- Unit-IV : Nuclear Power: Introduction, nuclear fusion reaction, requirement of nuclear fusion, plasma confinement, magnetic confinement fusion, inertial confinement fusion characteristics of DT reaction, advantages of nuclear fusion, cold fusion (current status ).
- Unit-V : Magneto Hydro dynamic Power(MHD): Introduction, principle of MHD power generation, MHD systems: open cycle system, close cycle system, advantages of MHD systems, electrical conditions, voltage and power output of MHD generator, materials of MHD generator. Future prospects of MHD power generation.

**SEMESTER-II**

**Paper - V (2NCES1)**

***(Geo-Thermal Energy, Tidal Energy and Thermoelectric Power)***

- Unit-I : Introduction to Geo-thermal Sources , nature of geothermal fields, geo-thermal sources, binary fluid geo-thermal power system and arrangement for hybrid plants Prime movers of Geothermal energy conversion, advantages and disadvantages, application of Geothermal energy
- Unit-II : Direct heat utilization of geothermal resources, introduction to geothermal greenhouse design, introduction to geothermal heat pumps, geochemical and geophysical method in geothermal exploration, economics and financing, geothermal energy sources of India.
- Unit-III : Introduction, basic principle, site selection. Energy from tides – basic principles of tidal power, components of tidal power plant. Tidal power plants, advantages and disadvantages. Wave energy, energy and power from waves, wave energy conversion devices, advantages and disadvantages.
- Unit-IV : Introduction of Hydrogen energy, Hydrogen production, electrolysis, thermochemical methods, fossil fuel method, solar energy method, bio-hydrogen production. Storage: Gaseous storage, Liquid storage, solid state storage, Hydrogen utilization, Hydrogen as an alternative for motor vehicles, safety.
- Unit-V : Thermoelectric Power: Introduction basic principles, thermoelectric power generators, performance analysis, thermoelectric materials and their selection.  
Introduction to micro-hydel, operating principle, components of microhydal power plants,

**Paper – VI (2NCES2)**

***(Bio-mass and Bio-gas Technology)***

- Unit-I : Biomass Chemistry: organic chemistry, carbohydrate chemistry, sugar, starch, cellulose, lignin, vegetable oil. Biomass resources:- Energy crops, Agricultural residues, Herbaceous biomass, woody biomass, waste materials, Introduction to thermochemical conversion process(combustion, gasification, Pyrolysis)
- Unit-II : Biological Process : Enzymatic Reactions, bioprocess microbiology. Bio-ethanol production process ( Saccharification and hydrolysis, fermentation process, Ethanol purification); Bio-diesel production process( materials, Biochemical reaction, production); Biobutanol production process (Metabolism, fermentation, Bio-butanol recovery).
- Unit-III : Anaerobic digestion: Anaerobic microorganisms, methane production process, review of anaerobic digesters of biogas. Material for biogas production; Chemical composition of biogas, effect of temperature and pH on biogas production, kinematic models predicting the methane yields. Comparative biogas yield from different organic wastes and factors affecting yield,

- Unit-IV : Biogas Plants: Engineering design of biogas units, design parameters affecting and failure of biogas system, Types of digesters (Floating dome, fixed dome, plug flow type etc). Structural behavior and conditions of fixed dome and floating dome digester. Operation and maintenance of biogas plants. Introduction to community biogas plant.
- Unit-V : Biogasholders types, Low pressure, Medium and high pressure biogas holders, Removal of hydrogen Sulfide, Sulfide precipitation, Adsorption on activated charcoal and molecular sieves, Removal of CO<sub>2</sub> by adsorption process. Utilization of biogas as a cooking and lighting, fuel for internal combustion engines.

**Paper – VII (2NCES3)**  
**(Introduction to Material Science and Characterization)**

- Unit-I : Free electron theory of metals Motion of electrons in periodic potential. The Kronig-Penny Model, Energy Band gaps and the Classification of Solids on the basis of band theory. Band Structure of Semiconductors., Generation and recombination processes in semiconductors.
- Unit-II : Semiconductor Processing technology, crystal growth, high temperature processing and implantation. Diffusion, ion implantation, oxidation, rapid thermal processing.
- Unit-III : Nanotechnology: Nano particles, nano materials, nanostructure materials, bottom up and top down approach, nanostructured solar cells.
- Unit-IV : Thin film deposition electron beam deposition and sputtering, chemical vapor deposition, epitaxial growth. Scope and application of thin films in solar cell
- Unit-V : Electrical characterization: resistivity, carrier doping and density, contact resistance Optical characterisation: microscopy, X-ray diffraction, Raman Spectroscopy.

**Paper -VIII (2NCES4)**  
**(Economics of Energy management Energy Policy)**

- Unit-I : Economics of renewable energy sources, feasibility studies, key factors affecting feasibility, cost estimation, optimization and risk management. Introduction to carbon credit.
- Unit-II : Environmental and financial cost of energy use, of production and of consumption. Practical savings within the context of building a management program, options for purchasing energy.
- Unit-III : Role of energy in economic development and social transformation: energy and GDP and GNP. Discovery of energy sources: Energy sources and overall energy demand and availability, energy consumption and projected future demand.
- Unit-IV : Indian Energy Scenario: Available energy resources present and future projection of consumption pattern, Need for use of new and renewable energy sources. Energy Conservation act-2001 and its features, electricity Act-2003 and its features, Framework of central electricity Authority, Central and state electricity Regulatory Commissions
- Unit-V : Energy policy: Global energy issues, National and state level energy issues, national and state energy policy, industrial energy policy. Energy security. International energy policies of G-8 countries, G-20 countries, OPEC and EU countries.

**Semester:-I**

**PRACTICAL I: (LAB-I): A student should perform at least seven experiments from the following list. In the examination he will be asked to perform one experiment only**

1. To determine internal resistance of Battery.
2. To determine power consumed by domestic appliances : Light, ( CFL, Filament, Fluorescent Tube)
3. Testing of charging characteristics of batteries
4. Measurement of load and power factor for electrical utilities.
5. Determining efficiency of lighting system/load
6. Thermal analysis of flat plate collector
7. Determination of Heat loss in flat plate collector
8. Determination of Azimuth angle
9. Study on performance of Solar cooker
10. Study on performance of solar water heater.

**PRACTICAL II: (LAB-I): A student should perform at least seven experiments from the following list. In the examination he will be asked to perform one experiment only.**

1. Testing of solar cells for I-V characteristics
2. Design of Solar street light system
3. Study and compare various heat exchangers
4. Wind power and annual energy estimation from wind data.
5. Energy Content in Wind. (Prototype Wind Mill of 500W)
6. Study of horizontal Axis Wind Turbine
7. Study of vertical axis wind turbine
8. Wind power and annual energy estimation from wind data.
9. Study of Performance of Solar Lamp.
10. Study of two and three dimensional tracking system

### Semester-II

**PRACTICAL III: (LAB-III): A student should perform at least seven experiments from the following list. In the examination he will be asked to perform one experiment only**

1. Study of Chula and Gas stove
2. Study of Prototype of Biogas Plant
3. Flue gas analysis of petrol, diesel and LPG Engines
4. Estimation of thermal analysis of thermionic converter
5. Report on visit to hydraulic power plant
6. Report on visit to biogas plant
7. Report on visit to wind power generation plant
8. Characteristics of SPV system.
9. Determination of efficiency of DC/AC inverter.
10. Study of Lead Acid Battery as energy storage.
11. Performance of Gassifire.

#### PROJECT:

Every student will have to carry out a project in semester II. The subject of the project should be pertaining to the curriculum of the Diploma. It should be decided in consultation with the faculty.

A detail report of the project to be submitted at the time of Practical Examination of Semester II

#### Distribution of marks for the Project Work will be as follows:

1) Selection of Topic and Work-Plan	-	5 Marks
2) Mid-Semester presentation	-	10 Marks
3) Pre- Submission Presentation	-	10 Marks
4) Find Viva- Voce Examination	-	25 Marks

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Total 50 Marks  
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#### Reference Books:

1. Principles of Energy Conversion : A.W. Culp.
2. Direct Energy Conversion : M.A. Kettani
3. Energy Conversion systems : Begamudre, Rakoshdas
4. Direct Energy Conversion : W.R. Corliss
5. Alternative Liquid fuels : B.V. Desai
6. Analysis and design of Energy Systems - Hogde b.K. (Prentice hall 1988)
7. Energy management and control system – Vol-I, II – M.C. Macedo ( John Willy )
8. Energy Conservation guide book Patrick/Patrick/Fardo ( Prentice hall 1993)
9. Handbook on Energy efficiency –

#### Reference Books : (BIOMASS)

1. Biomass Renewable Energy – D.O. hall and R.P. Overeed ( John Wiley and Sons, New york, 1987)
2. Biomass for energy in the developing countries – D.O. Hall, G.W. barnard and P.A. Moss (Pergamon Press Ltd. 1982)
3. Thermo chemical processing of Biomass, Bridgurater A V.
4. Biomass as Fuel – L.P. White (Academic press 1981)
5. Biomass Gasification Principles and Technology, Energy technology review No. 67, - T.B. Read (Noyes Data Corp. 1981)

#### Reference Books : (WIND ENERGY)

1. Wind energy Conversion Systems – Freris L.L. (Prentice Hall 1990)
2. Wind Turbine Technology: Fundamental concepts of wind turbine technology Spera D.A. (ASME Press, NY, 1994)
3. Wind Energy Systems – G.L. Johnson (Prentice Hall, 1985)
4. Wind Energy Explained – J.F. Manwell, J.G. McGowan and A.L. Rogers (John Wiley & Sons Ltd.)

**Reference Books : (SOLAR, WIND , OCEAN, GEOTHERMAL)**

1. Renewable Sources of Energy and Conversion Systems: N.K. Bansal and M.K. Kleeman.
2. Principles of Thermal Process : Duffie -Beckman.
3. Solar Energy Handbook: Kreith and Kreider (McGrawHill)
4. Solar Cell : Marteen A. Green
5. Solar Hydrogen Energy Systems -T. Ohta (Ed.) (Pergamon Press)
6. Hydrogen Technology for Energy – D.A. Maths (Noyes Data Corp.)
7. Handbook : Batteries and Fuel cell – Linden (Mc.Graw Hill)
8. Batteries Volume (I) and (II) – Collins
9. Anna Mani : Wind Energy Data for India
10. C-Wet : Wind Energy Resources Survey in India VI
11. S. Rangrajan : Wind Energy Resources Survey in India V
12. Sathyajith Mathew : Wind Energy Prepared by WISE: Wind Power in India (5000MW BY
13. B.H.Khan: Non-Conventional Energy Sources

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