

**Programme Structure, Curriculum & Scheme of  
Examination  
2019-20**

**Master of Technology**

**(Solar & Alternative Energy)**

**Programme Code: MTS**

**Duration – 2 Years Full Time**

## PROGRAMME STRUCTURE

### FIRST SEMESTER

Code	Title	Category	L	T	P	Credit
MTS 101	Heat Transfer in Renewable Energy Systems	CC	3	-	-	3
MTS 102	Photovoltaic and Fuel Cells System	CC	3	-	-	3
MTS 103	Renewable Energy System	CC	3	-	-	3
MTS 121	Practical – I	CC	-	-	6	3
<b>DE Electives: Student has to select 1 Course from the list of following DE Elective</b>						
MTS 104	Wind and Hydro Energy System	DE	3	-	-	3
MTS 105	Electronic Devices and Circuits	DE	3	-	-	3
MTS 106	Semiconductor Device fabrication Technology	DE	3	-	-	3
<b>OPEN ELECTIVE</b>						
	Open Elective – 2	OE	3	-	-	3
<b>Value Added</b>						
BCS 111	Communication Skills – I	VA	1	-	-	1
BSS 111	Behavioural Science – I	VA	1	-	-	1
	Foreign Language – I	VA	2	-	-	2
FLT 111	French					
FLG 111	German					
FLS 111	Spanish					
FLC 111	Chinese					
<b>TOTAL</b>						<b>22</b>
Note:- CC - Core Course, VA - Value Added Course, OE - Open Elective, DE - Domain Elective, FW - Field Work						

### SECOND SEMESTER

Code	Title	Category	L	T	P	Credit
MTS 201	Design of Solar thermal system	CC	3	-	-	3
MTS 202	Design of Solar Photovoltaic Cells	CC	3	-	-	3
MTS 203	Sustainable Building	CC	3	-	-	3
MTS 221	Practical – II	CC	-	-	6	3
MTS 255	Seminar	CC	-	-	-	4
<b>DE Electives: Student has to select 1 Course from the list of following DE Elective</b>						

MTS 204	Instrumentation and Control of Energy System	DE	3	-	-	3
MTS 205	Advanced Refrigeration System	DE	3	-	-	3
MTS 206	Energy and Environmental Policies	DE	3	-	-	3
<b>OPEN ELECTIVE</b>						
	Open Elective-2	OE	3	-	-	3
<b>Value Added</b>						
BCS 211	Communication Skills – II	VA	1	-	-	1
BSS 211	Behavioural Science – II	VA	1	-	-	1
FLT 211	Foreign Language – II	VA	2	-	-	2
FLG 211	French					
FLS 211	German					
FLC 211	Spanish					
	Chinese					
<b>TOTAL</b>						<b>26</b>
Note:- CC - Core Course, VA - Value Added Course, OE - Open Elective, DE - Domain Elective, FW - Field Work						

**\*SUMMER TRAINING DURING THE SUMMER BREAK**

**THIRD SEMESTER**

Code	Title	Category	L	T	P	Credit
MTS 301	Advanced Photovoltaic Technologies	CC	3	-	-	3
MTS 302	Industrial Energy Management System	CC	3	-	-	3
MTS 370	Minor Project: Energy Efficient Building Design	CC	-	-	-	6
MTS 350	Summer Training (Evaluation)	CC	-	-	-	4
<b>DE Electives: Student has to select 1 Course from the list of following DE Elective</b>						
MTS 303	Waste to Energy conversion technologies	DE	3	-	-	3
MTS 304	Grid Connectivity and Smart Grid System	DE	3	-	-	3
MTS 305	Research Methodology	DE	3	-	-	3
<b>OPEN ELECTIVE</b>						
	Open Elective-3	OE	3	-	-	3

<b>Value Added</b>						
BCS 311	Communication Skills – III	VA	1	-	-	1
BSS 311	Behavioural Science – III	VA	1	-	-	1
FLT 311	French	VA	2	-	-	2
FLG 311	German					
FLS 311	Spanish					
FLC311	Chinese					
<b>TOTAL</b>						<b>26</b>
Note:- CC - Core Course, VA - Value Added Course, OE - Open Elective, DE - Domain Elective, FW - Field Work						

#### **FOURTH SEMESTER**

MTS 455	Dissertation	CC	-	-	-	30	
	<b>TOTAL</b>					<b>30</b>	

## Curriculum & Scheme of Examination

### HEAT TRANSFER IN RENEWABLE ENERGY SYSTEM

**Course Code: MTS 101**

**Credit Units: 03**

#### **Course Objective:**

Course provides introduction to different mode of heat transfer. It develops the understanding of energy, heat, work, efficiency and ideal thermodynamic cycle mechanisms involved with renewable energy systems.

#### **Module I**

Introduction, different forms of energy, Thermodynamic system - types – properties – state- equilibrium –processes – cycles – Temperature – Zero<sup>th</sup> Law of thermodynamics – First Law of thermodynamics for closed and open systems – Concept of internal energy Limitations of first law – Second Law of thermodynamics – Concept of Entropy

#### **Module II**

Heat Transfer in Renewable Energy Systems - conduction, convection and radiation, Heat transfer and engineering concepts to the renewable energy systems (e.g., solar, geothermal and wind) and the supporting technologies (thermal energy storage, solid state hydrogen storage/compression, fuel cell, rechargeable battery, and thermoelectric).

#### **Module III**

The solar energy resource, Earth & Sun Relation,; Analysis of Indian solar radiation data and applications, Geothermal Energy and Ground-Source, Application of thermal dynamics in analysis, design and control of heating/cooling systems.

#### **Module IV**

Introduction to bioconversions; bioconversions of solar energy into bio-fuels; production of biomass (photosynthesis) Algal biofuel; biogas; bio-diesel; bio-based alcohols; sources; production and industrial applications; present and future scenario of bio-based conversions of solar energy into useful energy.

#### **Examination Scheme:**

Components	CT	Assignment/V/Q	Attendance	ESE
Weightage (%)	15	30	5	50

#### **Text & References:**

- Heat and Thermodynamics: R. H. Dittman and M. W. Zemansky
- Heat Transfer-a basic Approach: Ozisik
- Renewable energy engineering and technology-edited by V. V.N. Kishore
- Paul Gipe, Wind Energy Comes of Age, John Wiley & Sons Inc.
- L.L. Freris, Wind Energy Conversion System, Printice Hall.
- Tony Burton et al, Wind energy Hand Book, John Wiley & Sons Inc.
- Directory, Indian Windpower 2004, CECL, Bhopal.

# PHOTOVOLTAIC AND FUEL CELLS SYSTEM

**Course Code: MTS 102**

**Credit Units: 03**

## **Course Objective:**

This course covers the general aspects of design and operation of modern fuels cells and photovoltaic systems. Students are expected to have understood the fundamentals of fuel cell and photovoltaic systems, thermodynamics materials and systems dynamics. By attending this subject, students are expected to gain knowledge of the general design and working principle of fuel cells and photovoltaic systems.

## **Module I**

Fundamentals of solar cell, semiconductors as basis for solar cells materials and properties, P-N junction, sources of losses and prevention, estimating power and energy demand, site selection, land requirements,

## **Module II**

Solar cell, choice of modules, economic comparison, off grid systems, grid interface, Supporting structures, mounting and installation, battery storage, power condition unit, selection of cables, maintenance and schedule, Monitoring, Data Management, Performance Analysis and Financial Analysis

## **Module III**

Solar PV power plants: Array design, inverter types and characteristics, Power conditioning system: working algorithms, performance analysis; design of stand alone, hybrid and grid interactive plants, commissioning of solar PV plant

## **Module IV**

Fuel Cells: Thermodynamics of fuel cells; free energy change and cell potentials; effects of temperature and pressure on cell potential; energy conversion efficiency; factors affecting conversion efficiency; polarization losses; important types of fuel cells, electrode types; electrolytes for fuel cells; applications.

## **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

## **Text & References:**

- Solar Photovoltaics: Fundamentals, Technologies and Applications by Chetan Singh Solanki, Prentice Hall, India
- Terawatt Solar Photovoltaics, Roadblocks and Opportunities Edited by M. Tao, Springer
- Handbook of Photovoltaic Science and Engineering, Edited by A. Luque and S. Hegedus, John Wiley & Sons, Ltd

# RENEWABLE ENERGY SYSTEM

**Course Code: MTS 103**

**Credit Units: 03**

## **Course Objective:**

Basic objective of this subject is to impart knowledge on the awareness about renewable Energy Sources and technologies, adequate inputs on a variety of issues in harnessing renewable Energy and Recognize current and possible future role of renewable energy sources

## **Module I**

Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Sustainable Design and development, Types of RE sources, Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources.

## **Module II**

Solar radiation, Radiation measurement, Solar thermal power plant, Classification of solar thermal plant, Central receiver power plant, solar pond etc, basic principle of SPV conversion, Types of PV system and solar cells

## **Module III**

Biomass energy, Biomass resources, Energy from biomass, conversion process, biomass cogeneration, environmental benefit, geothermal energy, basics, direct use, geothermal to electricity, Mini/micro hydropower, classification, essential component of hydro power plant.

## **Module IV**

Tidal Energy, energy from tides, wave energy, ocean thermal energy conversion, Energy storage system, Hybrid energy system

## **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	<b>15</b>	<b>30</b>	<b>5</b>	<b>50</b>

## **Text & References:**

- M.A. Green (1982). Solar Cells: Operating Principles, Technology and Practice.
- T. Markvart (2000; for PV part). Solar Electricity (2nd edition).
- F. Lasnier and T.G. Ang (1990). Photovoltaic Engineering Handbook.
- H.S. Rauschenbach (1980). Solar cell array design handbook : the principles and technology of photovoltaic energy conversion.
- M. Archer and R. Hill (eds) (2001). Clean Electricity from Photovoltaics.
- M.A. Green. Silicon Solar Cells: Advanced Principles and Practice. Centre for Photovoltaic Devices and Systems.
- J. Larminie and A. Dicks (2001). Fuel Cells Systems Explained.
- Goetzberger, J. Knobloch and B. Voss (1998). Crystalline silicon solar cells.

## PRACTICAL - I

**Course Code: MTS 121**

**Credit Units: 03**

### Experiment List

1. Rectification and I-V characteristics of a diode.
2. Analysis and absorbance calculation of unknown component in solution through UV/VIS Spectrophotometry.
3. (a) To prepare thin films of polymer by spin coating technique.  
(b) To study the absorption spectra using UV –spectrophotometer.
4. To design clipping circuit for given specification and hence to plot its output.
5. Preparation of thin films of polymer doped with carbon nano-tubes and their electrical characterization.
6. To record and study the emission spectra of a light emitting diode.

### Examination Scheme:

IA				EE	
A	PR	LR	V	PR	V
5	10	10	5	35	35

Note: IA –Internal Assessment, EE- External Exam, PR- Performance, LR – Lab Record, V – Viva.



# WIND AND HYDRO ENERGY SYSTEM

**Course Code: MTS 104**

**Credit Units: 03**

## **Course Objective:**

Basic objective of this subject is to impart knowledge on the awareness about Wind Energy and Hydro energy Sources and technologies, adequate inputs on a variety of issues in harnessing renewable Energy and Recognize current and possible future role of renewable energy sources

## **Module I**

Wind Energy Basics: Status, Advantages and disadvantages of wind energy systems, Advantages and disadvantages, Types of wind energy converters, local Effects on wind, site selection: roughness length, wind shear, Wind Speed Variability, Obstacles to wind flow

## **Module II**

Working principles of wind energy: Energy content in wind, Energy Conversion at the Blade, Wind variations: Weibull distribution, Components of a wind energy converter: Rotor Blades, Gearboxes, Synchronous or Asynchronous Generators, Towers, Miscellaneous components, Turbine Selection, Operation and Control of Wind Energy Converters: grid requirements, Issue of Noise and Its Control, Power Curve and Capacity Factor, Pitch control, Stall Control, Yaw Control

## **Module III**

Hydropower basics: Water Cycle in Nature, Classification of Hydropower Plants, Status of Hydropower Worldwide, Advantages and Disadvantages of Hydropower, Operational Terminology, Legal Requirements Working principles: Locating a Hydropower Plant, Basics of Fluid Mechanics for hydro power, single and multiple reservoir system, cascaded power plants

## **Module IV**

Important Parts of Hydropower Station: Turbine, Electric Generator, Transformer and Power House, Structural parts: Dam and Spillway, Surge Chambers, Stilling Basins, Penstock and Spiral Casing, Tailrace, Pressure Pipes, Caverns, auxilliary parts. Hydraulic turbines: Classification of Hydraulic Turbines, Theory of Hydro Turbines: Francis, Kaplan, Pelton turbines, efficiency and selection of turbine.

## **Examination Scheme:**

Components	CT	Assignmen t	V/Q	Attendance	EE(1)
Weightage (%)	15	5	5	5	70

## **Text & References:**

- Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ISBN 978-0791812051, 1994.
- Johnson, G.L., Wind Energy Systems, Prentice Hall, ISBN 978-0139577543, 1985.Wagner, Hermann-Josef, Mathur, Jyotirmay,
- Introduction to Hydro Energy Systems Basics, Technology and Operation, Springer ISBN 978-3-642-20709-9, 2011

# ELECTRONIC DEVICES AND CIRCUITS

**Course Code: MTS 105**

**Credit Units: 03**

## **Course Objective:**

To enable the students about basics of Electronic devices and circuits

## **Course Contents:**

### **Module I**

pn junction, V I characteristics of pn junction diode, rectifier, zener diode and its application, LED, Diode circuits; clipper, clamper circuits

### **Module II**

BJT characteristics; BJT biasing; CE-biasing circuits: fixed bias, emitter-stabilized bias, voltage-divider bias, JFET, MOSFET.

### **Module III**

Operational amplifier: basic model; OpAmp as inverting amplifier; non-inverting amplifier; summing amplifier, integrator; differentiator; Schmitt trigger.

### **Module IV**

Logic Gates, Introduction to combinational circuits, combination circuit: Multiplexer: Decoder, Encoder; Minimization techniques: K MAP.

### **Module V**

Introduction to Sequential Design. Flip-flop: latch; S-R flip-flop; JK master slave flip-flop; D-flip flop; FF type conversion;

## **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

## **Text & References:**

- R.L. Boylestad, L. Nashelsky, *Electronic devices and circuit theory*, Prentice Hall,
- R.A. Gayakwad, *Op-amps and linear integrated circuits*, Prentice Hall of India,
- M. Morris Mano, *Digital Design*, Prentice Hall of India,
- R P Jain, *Modern Digital Electronics*, Tata McGrawHill,

# SEMICONDUCTOR DEVICE FABRICATION TECHNOLOGIES

**Course Code: MTS 106**

**Credit Units: 03**

## **Course Objective:**

Basic introduction to semiconductor device fabrication processes.

## **Course Contents:**

### **Module I:**

Recessing environments and wafer cleaning technology, introduction to clean room technology, clean room classification and operations, Wafer preparation, cleaning of wafers, wet cleaning, dry cleaning

### **Module II:**

Dopant Diffusion and related operations, Equipment for diffusion and related operations, laws of diffusion, dopants and dopant sources, oxidation of silicon, diffusion process control

### **Module III:**

Photolithography and Etching, Optical, electron and X-ray lithography, ion lithography. Etch mechanisms, selectivity and profile control, Reactive plasma etching techniques and equipment, plasma processing processes, wet chemical etching

### **Module IV:**

Ion implantation, Charged particles and fields, ion implantation basics and processes, ion implantation for substrate doping, technology trends

### **Module V:**

Metallization, introduction to vacuum science and technology, Metal deposition techniques, Vapor deposition: thermal evaporation, e-beam and sputtering techniques, silicide process, Metal CVD, copper metallization

## **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	<b>15</b>	<b>30</b>	<b>5</b>	<b>50</b>

## **Text & References:**

- ULSI Technology C.Y. Chang & S.M. Sze
- Introduction to Semiconductor Manufacturing Technology, Hang Kiao
- The Theory and Practice of Microelectronics, Sorab K. Gandhi.
- Fundamentals of semiconductor device fabrication, S.M. Sze

## COMMUNICATION SKILLS – I

**Course Code: BCS 111**

**Credit Units: 01**

### **Course Objective:**

The Course is designed to give an overview of the four broad categories of English Communication thereby enhance the learners' communicative competence.

### **Course Contents:**

#### **Module I: Listening Skills**

Effective Listening: Principles and Barriers  
Listening Comprehension on International Standards

#### **Module II: Speaking Skills**

Pronunciation and Accent  
Reading excerpts from news dailies & magazines  
Narrating Incident; Story telling.  
Extempore & Role Plays

#### **Module III: Reading Skills**

Vocabulary: Synonyms, antonyms, diminutives, homonyms, homophones  
Idioms & phrases  
Foreign words in English

#### **Module IV: Writing Skills**

Writing Paragraphs  
Précis Writing  
Letter writing  
Coherence and structure  
Essay writing

#### **Module V: Activities**

News reading  
Picture reading  
Movie magic  
Announcements

### **Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>CAF</b>	<b>V</b>	<b>GD</b>	<b>GP</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	25	10	10	10	5

CAF – Communication Assessment File

GD – Group Discussion

GP – Group Presentation

### **Text & References:**

- Working in English, Jones, Cambridge
- Business Communication, Raman – Prakash, Oxford
- Speaking Personally, Porter-Ladousse, Cambridge

**BEHAVIOURAL SCIENCE - I  
(SELF-DEVELOPMENT AND INTERPERSONAL SKILLS)**

**Course Code: BSS 111**

**Credit Units: 01**

**Course Objective:**

This course aims at imparting an understanding of:

Self and the process of self exploration

Learning strategies for development of a healthy self esteem

Importance of attitudes and their effect on work behaviour

Effective management of emotions and building interpersonal competence.

**Module I: Understanding Self**

Formation of self concept

Dimension of Self

Components of self

Self Competency

**Module II: Self-Esteem: Sense of Worth**

Meaning and Nature of Self Esteem

Characteristics of High and Low Self Esteem

Importance & need of Self Esteem

Self Esteem at work

Steps to enhance Self Esteem

**Module III: Emotional Intelligence: Brain Power**

Introduction to EI

Difference between IQ, EQ and SQ

Relevance of EI at workplace

Self assessment, analysis and action plan

**Module IV: Managing Emotions and Building Interpersonal Competence**

Need and importance of Emotions

Healthy and Unhealthy expression of emotions

Anger: Conceptualization and Cycle

Developing emotional and interpersonal competence

Self assessment, analysis and action plan

**Module V: Leading Through Positive Attitude**

Understanding Attitudes

Formation of Attitudes

Types of Attitudes

Effects of Attitude on

Behaviour

Perception

Motivation

Stress

Adjustment

Time Management

Effective Performance

Building Positive Attitude

**Module VI: End-of-Semester Appraisal**

Viva based on personal journal  
Assessment of Behavioural change as a result of training  
Exit Level Rating by Self and Observer

**Text & References:**

- Towers, Marc: Self Esteem, 1<sup>st</sup> Edition 1997, American Media
- Pedler Mike, Burgoyne John, Boydell Tom, A Manager's Guide to Self-Development: Second edition, McGraw-Hill Book Company.
- Covey, R. Stephen: Seven habits of Highly Effective People, 1992 Edition, Simon & Schuster Ltd.
- Khera Shiv: You Can Win, 1<sup>st</sup> Edition, 1999, Macmillan
- Gegax Tom, Winning in the Game of Life: 1<sup>st</sup> Edition, Harmony Books
- Chatterjee Debashish, Leading Consciously: 1998 1<sup>st</sup> Edition, Viva Books Pvt. Ltd.
- Dr. Dinkmeyer Don, Dr. Losoncy Lewis, The Skills of Encouragement: St. Lucie Press.
- Singh, Dalip, 2002, Emotional Intelligence at work; First Edition, Sage Publications.
- Goleman, Daniel: Emotional Intelligence, 1995 Edition, Bantam Books
- Goleman, Daniel: Working with E.I., 1998 Edition, Bantam Books.

## FRENCH – I

**Course Code: FLT 111**

**Credit Units: 02**

### **Course Objective:**

To familiarize the students with the French language with the phonetic system, with the syntax, with the manners, with the cultural aspects

### **Course Contents:**

#### **Module A: pp. 01 to 37: Unités 1, 2, Unité 3 Objectif 1,2**

Only grammar of Unité 3: objectif 3, 4 and 5

#### **Contenu lexical: Unité 1: Découvrir la langue française : (oral et écrit)**

1. se présenter, présenter quelqu'un, faire la connaissance des autres, formules de politesse, rencontres
2. dire/interroger si on comprend
3. Nommer les choses

#### **Unité 2: Faire connaissance**

1. donner/demander des informations sur une personne, premiers contacts, exprimer ses goûts et ses préférences
2. Parler de soi: parler du travail, de ses activités, de son pays, de sa ville.

#### **Unité 3: Organiser son temps**

1. dire la date et l'heure

#### **Contenu grammatical:**

1. organisation générale de la grammaire
2. article indéfini, défini, contracté
3. nom, adjectif, masculin, féminin, singulier et pluriel
4. négation avec « de », "moi aussi", "moi non plus"
5. interrogation : Inversion, est-ce que, qui, que, quoi, qu'est-ce que, où, quand, comment, quel(s), quelle(s)  
Interro-négatif : réponses : oui, si, non
6. pronom tonique/disjoint- pour insister après une préposition
7. futur proche

### **Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

### **Text & References:**

- le livre à suivre : Campus: Tome 1

# GERMAN – I

**Course Code: FLG 111**

**Credit Units: 02**

## **Course Objective:**

To enable the students to converse, read and write in the language with the help of the basic rules of grammar, which will later help them to strengthen their language.

To give the students an insight into the culture, geography, political situation and economic opportunities available in Germany

## **Course Contents:**

### **Module I: Introduction**

Self introduction: heissen, kommen, wohnen, lernen, arbeiten, trinken, etc.

All personal pronouns in relation to the verbs taught so far.

Greetings: Guten Morgen!, Guten Tag!, Guten Abend!, Gute Nacht!, Danke sehr!, Danke!, Vielen Dank!, (es tut mir Leid!),

Hallo, wie geht's?: Danke gut!, sehr gut!, prima!, ausgezeichnet!,  
Es geht!, nicht so gut!, so la la!, miserabel!

### **Module II: Interviewspiel**

To assimilate the vocabulary learnt so far and to apply the words and phrases in short dialogues in an interview – game for self introduction.

### **Module III: Phonetics**

Sound system of the language with special stress on Diphthongs

### **Module IV: Countries, nationalities and their languages**

To make the students acquainted with the most widely used country names, their nationalities and the language spoken in that country.

### **Module V: Articles**

The definite and indefinite articles in masculine, feminine and neuter gender. All Vegetables, Fruits, Animals, Furniture, Eatables, modes of Transport

### **Module VI: Professions**

To acquaint the students with professions in both the genders with the help of the verb "sein".

### **Module VII: Pronouns**

Simple possessive pronouns, the use of my, your, etc.

The family members, family Tree with the help of the verb "to have"

### **Module VIII: Colours**

All the color and color related vocabulary – colored, colorful, colorless, pale, light, dark, etc.

### **Module IX: Numbers and calculations – verb "kosten"**

The counting, plural structures and simple calculation like addition, subtraction, multiplication and division to test the knowledge of numbers.

"Wie viel kostet das?"

### **Module X: Revision list of Question pronouns**



W – Questions like who, what, where, when, which, how, how many, how much, etc.

**Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

**Text & References:**

- Wolfgang Hieber, Lernziel Deutsch
- Hans-Heinrich Wangler, Sprachkurs Deutsch
- Schulz Griesbach, Deutsche Sprachlehre für Ausländer
- P.L Aneja, Deutsch Interessant- 1, 2 & 3
- Rosa-Maria Dallapiazza et al, Tangram Aktuell A1/1,2
- Braun, Nieder, Schmöe, Deutsch als Fremdsprache 1A, Grundkurs

## SPANISH – I

**Course Code: FLS 111**

**Credit Units: 02**

### **Course Objective:**

To enable students acquire the relevance of the Spanish language in today's global context, how to greet each other. How to present / introduce each other using basic verbs and vocabulary.

### **Course Contents:**

#### **Module I**

A brief history of Spain, Latin America, the language, the culture...and the relevance of Spanish language in today's global context.

Introduction to alphabets

#### **Module II**

Introduction to 'Saludos' (How to greet each other. How to present / introduce each other).

Goodbyes (despedidas)

The verb llamarse and practice of it.

#### **Module III**

Concept of Gender and Number

Months of the years, days of the week, seasons. Introduction to numbers 1-100, Colors, Revision of numbers and introduction to ordinal numbers.

#### **Module IV**

Introduction to SER and ESTAR (both of which mean To Be).Revision of 'Saludos' and 'Llamarse'. Some adjectives, nationalities, professions, physical/geographical location, the fact that spanish adjectives have to agree with gender and number of their nouns. Exercises highlighting usage of Ser and Estar.

#### **Module V**

Time, demonstrative pronoun (Este/esta, Aquel/aquella etc)

#### **Module VI**

Introduction to some key AR /ER/IR ending regular verbs.

### **Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

### **Text & References:**

- Español, En Directo I A
- Español Sin Fronteras

## CHINESE – I

**Course Code: FLC 111**

**Credit Units: 02**

### **Course Objective:**

There are many dialects spoken in China, but the language which will help you through wherever you go is Mandarin, or Putonghua, as it is called in Chinese. The most widely spoken forms of Chinese are Mandarin, Cantonese, Gan, Hakka, Min, Wu and Xiang. The course aims at familiarizing the student with the basic aspects of speaking ability of Mandarin, the language of Mainland China. The course aims at training students in practical skills and nurturing them to interact with a Chinese person.

### **Course Contents:**

#### **Module I**

Show pictures, dialogue and retell.

Getting to know each other.

Practicing chart with Initials and Finals. (CHART – The Chinese Phonetic Alphabet Called “Hanyu Pinyin” in Mandarin Chinese.)

Practicing of Tones as it is a tonal language.

Changes in 3<sup>rd</sup> tone and Neutral Tone.

#### **Module II**

Greetings

Let me Introduce

The modal particle “ne”.

Use of Please ‘qing’ – sit, have tea ..... etc.

A brief self introduction – Ni hao ma? Zaijian!

Use of “bu” negative.

#### **Module III**

Attributives showing possession

How is your Health? Thank you

Where are you from?

A few Professions like – Engineer, Businessman, Doctor, Teacher, Worker.

Are you busy with your work?

May I know your name?

#### **Module IV**

Use of “How many” – People in your family?

Use of “zhe” and “na”.

Use of interrogative particle “shenme”, “shui”, “ma” and “nar”.

How to make interrogative sentences ending with “ma”.

Structural particle “de”.

Use of “Nin” when and where to use and with whom. Use of guixing.

Use of verb “zuo” and how to make sentences with it.

#### **Module V**

Family structure and Relations.

Use of “you” – “mei you”.

Measure words

Days and Weekdays.

Numbers.

Maps, different languages and Countries.

**Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

**Text & References:**

- “Elementary Chinese Reader Part I” Lesson 1-10

# DESIGN OF SOLAR THERMAL SYSTEM

**Course Code: MTS 201**

**Credit Units: 03**

## **Course Objective:**

To cover areas related with the fundamentals of solar energy, storage, and design of solar appliances.

### **Module I**

Solar Radiation: Basics of Solar Radiation, instruments for measuring solar radiation, solar radiation geometry, empirical equations, solar radiation on tilted surfaces. Liquid Flat plate Collector: Basic elements, performance analysis, transmissivity - absorptivity, heat transfer coefficients and correlations, collector efficiency and heat removal factors, effects of various parameters, types of other liquid flat-plate collectors, transient analysis.

### **Module II**

Concentrating Collectors: Type of concentrating collectors and their general characteristics, geometry, heat transfer correlations, tracking requirements, performance analysis. Solar thermal power plants: Concentration and temperatures, error in concentration, parabolic geometries, paraboloid geometries(dish), heliostats, lay out, central receiver ,

### **Module III**

Component design: Energy balance of components, design process and parameters, thermodynamic basis for receiver design, tube receiver concept. Volumetric receiver, direct absorption receiver, receiver loss calculations, thermal storage for solar power plants.

### **Module IV**

Thermal Energy Storage: Basic methods, Sensible heat storage – liquids- solids-analysis, latent heat storage, thermo chemical storage, application of thermal storage. Solar field design: array design, control of solar collectors, piping layout, pumping requirements condition monitoring and maintenance systems. Performance analysis of miscellaneous solar applications: Solar Air heaters, solar pond, solar still, solar refrigeration

## **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

## **Text & References:**

- Solar Energy: Fundamentals, design, modeling and applications, Authored by G. N. Tiwari
- Renewable Energy Engineering and Technology, Edited by V.V. N. Kishore

## DESIGN OF SOLAR PHOTOVOLTAIC CELLS

**Course Code: MTS 202**

**Credit Units: 03**

### **Course Objective:**

This course covers the design and engineering of solar cells along with their modules and panels.

### **Module I:**

Introduction of Design and Engineering of Solar Cells, Various Commercialized, Un-commercialized Designs of Solar Cells (Homo-junction, multi-junction and concentrator solar cells; Si solar cells, CIGS, CIS, CdTe, quantum dots, organic, inorganic-organic hybrid, dye-sensitized solar cells), Various Processes for Maximizing the Light-Trapping and Absorption in Solar Cells, Anti-reflection coating & Surface texturing, Back surface reflector, Self-cleaning surface.

### **Module II:**

Packaging of Solar Photovoltaic Modules, Cell matrix, Layers of modules, Lamination, post-lamination and curing, Special modules.

### **Module III:**

Electrical & Optical Performance of Solar Photovoltaic Modules, Electrical & thermal characteristics, Fabrication spread and Mismatch losses, Local shading and Hot spot formation, Field performance of module, Troubleshooting of solar cells.

### **Module IV:**

Module Manufacturing of Commercialized Solar Cells, Module manufacturing of a-Si solar cells (Continuous roll-to-roll manufacturing, Si on glass substrate, manufacturing cost, safety & other issues, module performance), Module manufacturing of CIGS, CIS, CdTe solar cells.

### **Module V:**

Photovoltaic Power System Configuration and their Applications, Grid-independent PV system for small devices and appliances, PV systems for remote consumers, Decentralized grid-connected PV systems, Centralized grid-connected PV systems.

### **Examination Scheme:**

Components	CT	Assignment/V/Q	Attendance	ESE
Weightage (%)	15	30	5	50

### **Text & References:**

- Solar Photovoltaics (Fundamentals, Technologies and Application) by Chetan Singh Solanki; Handbook of Photovoltaic Science and Engineering by Antonio Luque & Steven Hegedus - Wiley; Lecture notes.

# SUSTAINABLE BUILDING DESIGN

**Course Code: MTS 203**

**Credit Units: 03**

## **Course Objective:**

The basic objective of this subject is to impart the knowledge of building design for reduction of energy consumption through solar radiation and its heat.

## **Module I**

Concept of green buildings features of green building rating systems in India: LEED, GRIHA. Sustainable site, water, energy, material and indoor environment issues for green buildings;

## **Module II**

Intent and documentation for credits/points for green rating systems; difference in evaluation and documentation for new construction, existing buildings, core and shell projects

## **Module III**

Green home rating system, green factory rating, green neighborhood concept; Concept of Net zero energy building, net zero community.

## **Module IV**

Energy Conservation Building Code: requirements of code, applicability, compliance options: prescriptive, trade-off, whole building performance routes for compliance

## **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

## **Text & References:**

- A Handbook of Sustainable Building Design and Engineering Edited By Dejan Mumovic, Mat Santamouris
- Sustainable Construction: Green Building Design and Delivery Edited By Charles Kibert
- A Handbook of Green Building Design and Construction Edited By Sam Kubba

## PRACTICAL - II

**Course Code: MTS 221**

**Credit Units: 03**

### **Experiment List:**

1. Fabrication of thermo couple based on thin films and its characterization.
2. Fabrication and characterization of MOS.
3. I-V measurements on Silicon Solar Cell.
4. Measurements of life time of minority carries in p-n junction solar cell.
5. Fabrication of organic LED and characterization.
6. Extraction of Bio-Fuel.
7. Multivibrator-Designs and analysis.

### **Examination Scheme:**

IA				EE	
A	PR	LR	V	PR	V
5	15	15	15	25	25

Note: IA –Internal Assessment, EE- External Exam, PR- Performance, LR – Lab Record, V – Viva.



## SEMINAR AND PROJECT

**Course Code: MTS 255**

**Credit Units: 04**

### Topics for the Project/Seminar

- |  |                     |
|--|---------------------|
| 1. Minority carrier Life time measurements -           | Dr. Vasuda. Bhatia  |
| 2. Organic Thin Film Devices for Energy Applications - | Dr. Kanchan. Saxena |
| 3. Bio-fuels using Algae -                             | Dr. Vasuda Bhatia   |

Students are required to select one topic for the project. A final report comprising of the following headers to be submitted to the committee prior to presentation.

1. Cover page-indicating title of the project, Guide's name
2. Introduction
3. Literature Survey
4. Methodology/Work Plan
5. Experimental set-up
6. Experimental data
7. Results and Discussion
8. Conclusion
9. Future Plan
10. References
11. Acknowledgments

### Examination Scheme:

Project work	65 %
Seminar	20 %
Viva	10 %
Attendance	5%
<b>Total:</b>	<b>100</b>

# INSTRUMENTATION AND CONTROL OF ENERGY SYSTEM

**Course Code: MTS 204**

**Credit Units: 03**

## **Course Objective:**

The basic objective of this subject is to impart the knowledge about Electronic Instrumentation used for the measurement of renewable energy applications.

## **Module I**

Basic measurement concepts, Error analysis, transducer classification, static and dynamic characteristics of transducers,

## **Module II**

Real time monitoring and data processing, instrumentation for measuring temperature, humidity, radiation, flow, pressure, thermal conductivity, specific heat etc

## **Module III**

Data loggers: type of loggers, configuring and checking data-loggers

## **Module IV**

Measurement of electrical quantities: current, voltage, power, power factor, stability, transient analysis of power generating systems

## **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

## **Text & References:**

- C.S. Rangan, G.R. Sharma and V.S.V. Mani, Instrumentation Devices and Systems, Tata McGraw-Hill, 1983.
- H.H. Willard, L.L. Merrit and John A. Dean, Instrumental Methods of Analysis, 6th edition, CBS Publishers & Distributors, 1986.
- Barry E. Jones, Instrumentation Measurement and Feedback, Tata McGrawHill, 1978.
- J.F. Rabek, Experimental Methods in Photochemistry and Photophysics, Parts 1 and 2, John Wiley, 1982.

## ADVANCED REFRIGERATION SYSTEM

**Course Code: MTS 205**

**Credit Units: 03**

### **Course Objective:**

This course covers the basic principles of refrigeration, cryogenics and alternate system of refrigeration

### **Course Contents:**

**Module I: Introduction :** Review of Second law of thermodynamics, COP, Unit of Refrigeration Reversed Carnot Cycle, Bell Coleman cycle, Vapour Compression Refrigeration system, Vapour absorption Refrigeration system.

**Module II: Psychrometry :** Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

**Module III: Solar Cooling :** Potential and scope of solar cooling, Types of solar cooling systems, Solar collectors and storage systems for solar refrigeration and air-conditioning, Solar operation of vapour absorption and vapour compression refrigeration cycles and their thermodynamic assessment, Rankine cycle, sterling cycle based solar cooling systems.

**Module IV: Solar Powered Refrigeration :** Jet ejector solar cooling systems, Fuel assisted solar cooling systems, Solar desiccant cooling systems, Open cycle absorption / desorption solar cooling alternatives, Advanced solar cooling systems,

**Module V: Solar Powered Air-conditioning:** Thermal modeling for continuous and intermittent solar refrigeration and air-conditioning systems, Refrigerant storage for solar absorption cooling systems, Solar thermoelectric refrigeration and air-conditioning, Solar thermo acoustic cooling and hybrid air-conditioning, Solar economics of cooling systems.

### **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

### **Text & References:**

- Refrigeration and Air – Conditioning By C.P. Arora
- Refrigeration and Air – Conditioning By P.K. Nag
- Refrigeration and Air – Conditioning By P. L. Ballaney

## ENERGY AND ENVIRONMENTAL POLICIES

**Course Code: MTS 206**

**Credit Units: 03**

### **Course Objective:**

The basic objective of this subject is to impart the knowledge about energy and environmental policies made by the government of India.

### **Module I**

Introduction to Energy codes and policies: Energy Conservation act, Electricity Act, Solar policy, Hydro policy, Biomass policy

### **Module II**

International scenario: world energy outlook, international protocols for energy and environment, governing and nodal national/international agencies and their role

### **Module III**

Financial tools: incentives and subsidies, calculation of required subsidy for penetration, concept of shadow price

### **Module IV**

Concept of micro-financing for RE, funding agencies for RE projects in India, application development for RE funding, Tariff policies, use of Demand Side Management as a policy tool

### **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

### **Text & References:**

- India's Energy and Climate Policy By Charles K. Ebinger
- Energy Law and Policy in India By Sai ram Bhatt

## COMMUNICATION SKILLS - II

**Course Code:BCS 211**

**Credit Units: 01**

### **Course Objective:**

To enrich the understanding of English language and communication, structure, style, usage, and vocabulary for global business purposes.

### **Module I: Fundamentals of Communication**

Role and purpose of communication: *7 C's of communication*

Barriers to effective communication

Enhancing listening

Forms of Communication: one-to-one, informal and formal

### **Module II: Verbal Communication (Written)**

Business Letter

Social correspondence

Writing resume and Job applications

### **Module III: Speaking skills**

Conversational English

Guidelines to give an effective presentation

Activities to include:

Presentations by students

Just a minute

### **Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>CAF</b>	<b>V</b>	<b>GD</b>	<b>GP</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	25	10	10	10	5

CAF – Communication Assessment File, GD – Group Discussion, GP – Group Presentation

### **Text & References:**

- Business Communication, Raman – Prakash, Oxford
- Textbook of Business Communication, Ramaswami S, Macmillan
- Speaking Personally, Porter-Ladousse, Cambridge

**BEHAVIOURAL SCIENCE - II**  
**(BEHAVIOURAL COMMUNICATION AND RELATIONSHIP MANAGEMENT)**

**Course Code: BSS 211**

**Credit Units: 01**

**Course Objective:**

This course aims at imparting an understanding of:  
Process of Behavioural communication  
Aspects of interpersonal communication and relationship  
Management of individual differences as important dimension of IPR

**Course Contents:**

**Module I: Behavioural Communication**

Scope of Behavioural Communication  
Process – Personal, Impersonal and Interpersonal Communication  
Guidelines for developing Human Communication skills  
Relevance of Behavioural Communication in relationship management

**Module II: Managing Individual Differences in Relationships**

Principles  
Types of issues  
Approaches  
Understanding and importance of self disclosure  
Guidelines for effective communication during conflicts

**Module III: Communication Climate: Foundation of Interpersonal Relationships**

Elements of satisfying relationships  
Conforming and Disconfirming Communication  
Culturally Relevant Communication  
Guideline for Creating and Sustaining Healthy Climate

**Module IV: Interpersonal Communication**

Imperatives for Interpersonal Communication  
Models – Linear, Interaction and Transaction  
Patterns – Complementary, Symmetrical and Parallel  
Types – Self and Other Oriented  
Steps to improve Interpersonal Communication

**Module V: Interpersonal Relationship Development**

Relationship circle – Peer/ Colleague, Superior and Subordinate  
Initiating and establishing IPR  
Escalating, maintaining and terminating IPR  
Direct and indirect strategies of terminating relationship  
Model of ending relationship

**Module VI: End-of-Semester Appraisal**

Viva based on personal journal  
Assessment of Behavioural change as a result of training  
Exit Level Rating by Self and Observer

## **Text & References:**

- Vangelist L. Anita, Mark N. Knapp, Inter Personal Communication and Human Relationships: Third Edition, Allyn and Bacon
- Julia T. Wood. Interpersonal Communication everyday encounter
- Simons, Christine, Naylor, Belinda: Effective Communication for Managers, 1997 1<sup>st</sup> Edition Cassell
- Harvard Business School, Effective Communication: United States of America
- Beebe, Beebe and Redmond; Interpersonal Communication, 1996; Allyn and Bacon Publishers.

## FRENCH - II

**Course Code: FLT 211**

**Credit Units: 02**

### **Course Objective:**

- To enable the students to overcome the fear of speaking a foreign language and take position as a foreigner speaking French.
- To make them learn the basic rules of French Grammar.

### **Course Contents:**

**Module A: pp.38 – 47: Unité 3: Objectif 3, 4, 5, 6**

**Module B: pp. 47 to 75 Unité 4, 5**

### **Contenu lexical: Unité 3: Organiser son temps**

1. donner/demander des informations sur un emploi du temps, un horaire SNCF – Imaginer un dialogue
2. rédiger un message/ une lettre pour ...
  - i) prendre un rendez-vous/ accepter et confirmer/ annuler
  - ii) inviter/accepter/refuser
3. Faire un programme d'activités  
imaginer une conversation téléphonique/un dialogue  
  
Propositions- interroger, répondre

### **Unité 4: Découvrir son environnement**

1. situer un lieu
2. s'orienter, s'informer sur un itinéraire.
3. Chercher, décrire un logement
4. connaître les rythmes de la vie

### **Unité 5: s'informer**

1. demander/donner des informations sur un emploi du temps passé.
2. donner une explication, exprimer le doute ou la certitude.
3. découvrir les relations entre les mots
4. savoir s'informer

**Contenu grammatical:** 1. Adjectifs démonstratifs

2. Adjectifs possessifs/exprimer la possession à l'aide de :

i. « de » ii. A+nom/pronom disjoint



3. Conjugaison pronominale – négative, interrogative -  
construction à l'infinitif
4. Impératif/exprimer l'obligation/l'interdiction à l'aide de « il  
faut.... »/ «il ne faut pas... »
5. passé composé
6. Questions directes/indirectes

**Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

**Text & References:**

- le livre à suivre : Campus: Tome 1

## GERMAN – II

**Course Code: FLG 211**

**Credit Units: 02**

### **Course Objective:**

To enable the students to converse, read and write in the language with the help of the basic rules of grammar, which will later help them to strengthen their language.

To give the students an insight into the culture, geography, political situation and economic opportunities available in Germany

Introduction to Grammar to consolidate the language base learnt in Semester I

### **Course Contents:**

#### **Module I: Everything about Time and Time periods**

Time and times of the day.

Weekdays, months, seasons.

Adverbs of time and time related prepositions

#### **Module II: Irregular verbs**

Introduction to irregular verbs like to be, and others, to learn the conjugations of the same, (fahren, essen, lessen, schlafen, sprechen und ähnliche).

#### **Module III: Separable verbs**

To comprehend the change in meaning that the verbs undergo when used as such  
Treatment of such verbs with separable prefixes

#### **Module IV: Reading and comprehension**

Reading and deciphering railway schedules/school time table  
Usage of separable verbs in the above context

#### **Module V: Accusative case**

Accusative case with the relevant articles  
Introduction to 2 different kinds of sentences – Nominative and Accusative

#### **Module VI: Accusative personal pronouns**

Nominative and accusative in comparison  
Emphasizing on the universal applicability of the pronouns to both persons and objects

#### **Module VII: Accusative prepositions**

Accusative propositions with their use  
Both theoretical and figurative use

## Module VIII: Dialogues

Dialogue reading: 'In the market place'  
'At the Hotel'

### Examination Scheme:

Components	CT1	CT2	C	I	V	A
Weightage (%)	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

### Text & References:

- Wolfgang Hieber, Lernziel Deutsch
- Hans-Heinrich Wangler, Sprachkurs Deutsch
- Schulz Griesbach, Deutsche Sprachlehre für Ausländer
- P.L Aneja, Deutsch Interessant- 1, 2 & 3
- Rosa-Maria Dallapiazza et al, Tangram Aktuell A1/1,2
- Braun, Nieder, Schmöe, Deutsch als Fremdsprache 1A, Grundkurs

## SPANISH – II

**Course Code:FLS 211**

**Credit Units: 02**

### **Course Objective:**

To enable students acquire more vocabulary, grammar, Verbal Phrases to understand simple texts and start describing any person or object in Simple Present Tense.

### **Course Contents:**

#### **Module I**

Revision of earlier modules.

#### **Module II**

Some more AR/ER/IR verbs. Introduction to root changing and irregular AR/ER/IR ending verbs

#### **Module III**

More verbal phrases (eg, Dios Mio, Que lastima etc), adverbs (*bueno/malo, muy, mucho, bastante, poco*).

Simple texts based on grammar and vocabulary done in earlier modules.

#### **Module IV**

Possessive pronouns

#### **Module V**

Writing/speaking essays like my friend, my house, my school/institution, myself....descriptions of people, objects etc, computer/internet related vocabulary

### **Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

### **Text & References:**

- Español, En Directo I A
- Español Sin Fronteras

## CHINESE – II

**Course Code: FLC 211**

**Credit Units: 02**

### **Course Objective:**

Chinese is a tonal language where each syllable in isolation has its definite tone (flat, falling, rising and rising/falling), and same syllables with different tones mean different things. When you say, “ma” with a third tone, it mean horse and “ma” with the first tone is Mother. The course aims at familiarizing the student with the basic aspects of speaking ability of Mandarin, the language of Mainland China. The course aims at training students in practical skills and nurturing them to interact with a Chinese person.

### **Course Contents:**

#### **Module I**

Drills

Practice reading aloud

Observe Picture and answer the question.

Tone practice.

Practice using the language both by speaking and by taking notes.

Introduction of basic sentence patterns.

Measure words.

Glad to meet you.

#### **Module II**

Where do you live?

Learning different colors.

Tones of “bu”

Buying things and how muchit costs?

Dialogue on change of Money.

More sentence patterns on Days and Weekdays.

How to tell time. Saying the units of time in Chinese. Learning to say useful phrases like – 8:00, 11:25, 10:30 P.M. everyday, afternoon, evening, night, morning 3:58, one hour, to begin, to end ..... etc.

Morning, Afternoon, Evening, Night.

#### **Module III**

Use of words of location like-li, wais hang, xia

Furniture – table, chair, bed, bookshelf,.. etc.

Description of room, house or hostel room.. eg what is placed where and how many things are there in it?

Review Lessons – Preview Lessons.

Expression ‘yao’, “xiang” and “yaoshi” (if).

Days of week, months in a year etc.

I am learning Chinese. Is Chinese difficult?

## Module IV

Counting from 1-1000

Use of “chang-chang”.

Making an Inquiry – What time is it now? Where is the Post Office?

Days of the week. Months in a year.

Use of Preposition – “zai”, “gen”.

Use of interrogative pronoun – “duoshao” and “ji”.

“Whose”??? Sweater etc is it?

Different Games and going out for exercise in the morning.

## Module V

The verb “qu”

Going to the library issuing a book from the library

Going to the cinema hall, buying tickets

Going to the post office, buying stamps

Going to the market to buy things.. etc

Going to the buy clothes .... Etc.

Hobby. I also like swimming.

Comprehension and answer questions based on it.

### Examination Scheme:

Components	CT1	CT2	C	I	V	A
Weightage (%)	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

### Text & References:

- “Elementary Chinese Reader Part I” Lesson 11-20

## ADVANCED PHOTOVOLTAIC TECHNOLOGIES

**Course Code: MTS 301**

**Credit Units: 03**

### **Course Objective:**

The objective of this subject is to impart the knowledge about recent available technologies used in designing of solar cells.

### **Module I**

Overview of different types of solar cells/panels, Photovoltaic industries in India and World, International certification of solar panels and Indian scenario

### **Module II**

Wafer based silicon solar cells and its market trend. Cost breakup of wafer based solar panels, future trends

Concentrator solar cells, reflector and lens based versions. Performance in Indian climatic conditions. Low, medium and high concentration, combined thermal and concentration PV system.

### **Module III**

Semi-transparent solar cells and related materials, applications in buildings (BIPV), thin film and wafer based versions, appearance and structure of thin film solar cells, Flexible solar cells.

### **Module IV**

Multi-junction solar cells, its working principles, Hetero-junction with intrinsic thin layer (HIT) solar cells, structure and working principle, comparison with conventional bulk solar cells,

Polymer, organic, dye sensitized and quantum dot solar cells, structure, working principle, present applications, near future trends.

### **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

### **Text & References:**

Photovoltaic Solar Energy: From Fundamentals to Applications By Wilfried van Sark Alexandre Freundlich

# INDUSTRIAL ENERGY MANAGEMENT SYSTEM

**Course Code: MTS 302**

**Credit Units: 03**

## **Course Objective:**

This course covers the basic principles of energy management, economics of solar energy and design of energy efficient building.

## **Module I**

Solar energy benefits, environmental benefits, solar energy cost and economic impact, understanding the cost of solar energy, economics of installing solar panel, solar cooling concepts and economic benefits

## **Module II**

Energy consumption in industries: Energy and material flow assessment, specific energy consumption, industry benchmarks for energy consumption.

## **Module III**

Energy audit: Process of energy audit, preliminary audit, detailed audit, reporting of energy audit, concept of ESCO, energy performance contracting, instruments for energy audit, management and organization of energy conservation programs in industries

## **Module IV**

Energy conservation in industrial systems: boilers, furnaces, pumps, fans and blowers, steam system, motors and transformers, power factor.

## **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	15	30	5	50

## **Text & References:**

- Renewable Energy: Power For A Sustainable Future, Second Ed. Edited By Godfrey Boyle
- Solar Engineering Of Thermal Processes - J. A. Duffie, W. A. Beckman, Solar Energy Laboratory Lecture Notes



## **MINOR PROJECT: ENERGY EFFICIENT BUILDING DESIGN**

**Course Code: MTS 370**

**Credit Units: 06**

### **Course Objective:**

To give a training of handling various projects with the help of minor project on 'Energy Efficient Building Design.'

### **Course Contents:**

Students will get exposure of how to carried out the project successfully. During this they will get an opportunity to interact with visiting faculties, who have their expertise in the same field. Students will submit their report to AIRAE after being examined by guide / supervisor under whom he/she will work.

### **Assessment Scheme:**

**Continuous Evaluation:** 40% (Based on punctuality, regularity of work, adherence to plan and methodology,

refinements/ mid-course corrections etc. as reflected in the Project File.)

**Final Evaluation:** 60% (Based on the Documentation in the file, Final report layout, analysis and results, achievement of objectives, presentation/ viva)

## SUMMER TRAINING EVALUATION

**Course Code: MTS 350**

**Credit Units: 04**

***Course Objective:***

To evaluate the project carried out in the industry during the summer internship.

***Summer Training Programme***

During the summer training, each student will be given an opportunity to interact with R&D institutions/Industries, where she/he will work on a project and get training of handling Solar Cell's fabrication / processing units for a short duration of 45-60 days. Students will submit the work to AIRAE after being examined by a guide/supervisor of the institute under whom she/he will work.

***Examination Scheme:***

Project	: 60%
Presentation/Seminar	: 20%
Viva	: 20%
<b>Total</b>	<b>: 100%</b>

## WASTE TO ENERGY CONVERSION TECHNOLOGY

**Course Code: MTS 303**

**Credit Units: 03**

### **Course Objective:**

To provide an understanding of the various aspects of Waste to Energy, various sources of waste generation, the best available technologies for waste to energy.

### **Course Contents:**

#### **Module I:**

Introduction- The Principles of Waste Management and Waste Utilization, Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source, Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous)

#### **Module II:**

Technologies for Waste to Energy Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation. Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies

#### **Module III:**

Case Studies – Success/failures of waste to energy Global Best Practices in Waste to energy production distribution and use. Indian Scenario on Waste to Energy production distribution and use in India. Success and Failures of Indian Waste to Energy plants. Role of the Government in promoting 'Waste to Energy'

#### **Module IV:**

Waste to Energy & Environmental Implications- Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms.

### **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	<b>15</b>	<b>30</b>	<b>5</b>	<b>50</b>

### **Text & References:**

- Rogoff, M.J. and Screve, F., "Waste-to-Energy: Technologies and Project Implementation", Elsevier Store.
- Harker, J.H. and Backhusrt, J.R., "Fuel and Energy", Academic Press Inc.
- EL-Halwagi, M.M., "Biogas Technology- Transfer and Diffusion", Elsevier Applied Science.
- Hall, D.O. and Overeed, R.P., " Biomass - Renewable Energy", John Willy and Sons.

## GRID CONNECTIVITY AND SMART GRID SYSTEM

**Course Code: MTS 304**

**Credit Units: 03**

### **Course Objective:**

#### **Module I**

Introduction to grid connectivity of RE systems, smart grid and emerging technologies, Operating principles and models of smart grid components, Key technologies for generation, networks, loads and their control capabilities; decision-making tools,

#### **Module II**

Non conventional energy source models grid integration, Micro-turbine model and grid integration, Fuel cell model and grid integration, Energy storage and electric vehicle models and grid integration, Distribution line models, Communication infrastructures for smart grid operation, Advanced metering infrastructure and advanced control methods,

#### **Module III**

Economic dispatch, Demand response and demand management, Distribution feeder analysis, Continuous voltage and frequency control, Contingencies and their management, Unit commitment (selection of generators & loads to operate), Energy constraints: hydro, fuel management and maintenance scheduling,

#### **Module IV**

The operational challenges of distributed energy resources, Operation and control issues associated with intermittent generation, Electricity industry operation in a carbon constrained and 'smart grid' future, Impact of smart grid component integration on distribution network operation, Artificial Intelligence based approaches for estimation, scheduling, management and control of next generation smart grid.

### **Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	<b>15</b>	<b>30</b>	<b>5</b>	<b>50</b>

### **Text & References:**

- Advances in Smart Grid and Renewable Energy By SenGupta, S., Zobia
- Smart Grid: Technology And Applications by Janaka Ekanayake and Kithsiri Liyanage

## RESEARCH METHODOLOGY

**Course Code: MTS 305**

**Credit Units: 03**

### **Course Objective:**

This course covers the concepts of research and flow of research in an organized manner

#### **Module I**

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process, Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis – Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance

#### **Module - II**

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches

#### **Module - III**

Measurement: Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

#### **Module -IV**

Data Analysis: Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ? Ethical issues related to publishing, Plagiarism and Self-Plagiarism.

#### **Module -V**

Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Computer Science Discipline. (5%) 10. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism

**Examination Scheme:**

<b>Components</b>	<b>CT</b>	<b>Assignment/V/Q</b>	<b>Attendance</b>	<b>ESE</b>
<b>Weightage (%)</b>	<b>15</b>	<b>30</b>	<b>5</b>	<b>50</b>

**Books Recommended:-**

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Research Methodology – C.R.Kothari
4. Select references from the Internet

## COMMUNICATION SKILLS - III

**Course Code: BCS 311**

**Credit Units: 01**

### **Course Objective:**

To initiate the learners with the basic mechanics of writing skills and facilitate them with the core skills required for communication in the professional world.

### **Course Contents:**

#### **Module I: Mechanics and Semantics of Sentences**

Writing effective sentences

Style and Structure

#### **Module II: Developing writing skills**

Inter - office communication: Business Letter; E mails; Netiquette

Intra – office communication: Memos, Notices, Circulars, Minutes

Report Writing

#### **Module III: Business Presentations**

Planning, design and layout of presentation

Information Packaging

Audience analysis

Audio visual aids

Speaking with confidence

Case Studies

### **Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>CAF</b>	<b>V</b>	<b>GD</b>	<b>GP</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	25	10	10	10	5

CAF – Communication Assessment File

GD – Group Discussion

GP – Group Presentation

**Text & References:**

- Krishnaswamy, N, Creative English for Communication, Macmillan
- Raman Prakash, Business Communication, Oxford.



**BEHAVIOURAL SCIENCE - III  
(LEADING THROUGH TEAMS)**

**Course Code: BSS 311**

**Credit Units: 01**

**Course Objective:**

This course aims to enable students to:  
Understand the concept and building of teams  
Manage conflict and stress within team  
Facilitate better team management and organizational effectiveness through universal human values.

**Course Contents:**

**Module I: Teams: An Overview**

Team Design Features: team vs. group  
Effective Team Mission and Vision  
Life Cycle of a Project Team  
Rationale of a Team, Goal Analysis and Team Roles

**Module II: Team & Sociometry**

Patterns of Interaction in a Team  
Sociometry: Method of studying attractions and repulsions in groups  
Construction of sociogram for studying interpersonal relations in a Team

**Module III: Team Building**

Types and Development of Team Building  
Stages of team growth  
Team performance curve  
Profiling your Team: Internal & External Dynamics  
Team Strategies for organizational vision  
Team communication

**Module IV: Team Leadership & Conflict Management**

Leadership styles in organizations  
Self Authorized team leadership  
Causes of team conflict  
Conflict management strategies  
Stress and Coping in teams

**Module V: Global Teams and Universal Values**

Management by values  
Pragmatic spirituality in life and organization  
Building global teams through universal human values  
Learning based on project work on Scriptures like Ramayana, Mahabharata, Gita etc.

**Module VI: End-of-Semester Appraisal**

Viva based on personal journal  
Assessment of Behavioural change as a result of training  
Exit Level Rating by Self and Observer

## **Text & References:**

- Organizational Behaviour, Davis, K.
- Hoover, Judith D. Effective Small Group and Team Communication, 2002, Harcourt College Publishers
- LaFasto and Larson: When Teams Work Best, 2001, Response Books (Sage), New Delhi
- Dick, Mc Cann & Margerison, Charles: Team Management, 1992 Edition, viva books
- J William Pfeiffer (ed.) Theories and Models in Applied Behavioural Science, Vol 2, Group (1996); Pfeiffer & Company
- Smither Robert D.; The Psychology of Work and Human Performance, 1994, Harper Collins College Publishers

## FRENCH – III

**Course Code: FLT 311**

**Credit Units: 02**

### **Course Objective:**

To provide the students with the know-how

- To master the current social communication skills in oral and in written.
- To enrich the formulations, the linguistic tools and vary the sentence construction without repetition.

### **Course Contents:**

**Module B: pp. 76 – 88 Unité 6**

**Module C: pp. 89 to 103 Unité 7**

#### **Contenu lexical:            Unité 6: se faire plaisir**

1. acheter : exprimer ses choix, décrire un objet (forme, dimension, poids et matières) payer
2. parler de la nourriture, deux façons d'exprimer la quantité, commander un repas au restaurant
3. parler des différentes occasions de faire la fête

#### **Unité 7: Cultiver ses relations**

1. maîtriser les actes de la communication sociale courante  
(Salutations, présentations, invitations, remerciements)
2. annoncer un événement, exprimer un souhait, remercier, s'excuser par écrit.
3. caractériser une personne (aspect physique et caractère)

#### **Contenu grammatical:**

1. accord des adjectifs qualificatifs
2. articles partitifs
3. Négations avec de, ne...rien/personne/plus
4. Questions avec combien, quel...
5. expressions de la quantité
6. ne...plus/toujours - encore

7. pronoms compléments directs et indirects
8. accord du participe passé (auxiliaire « avoir ») avec l'objet direct
9. Impératif avec un pronom complément direct ou indirect
10. construction avec « que » - Je crois que/ Je pense que/ Je sais que

**Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

**Text & References:**

- le livre à suivre : Campus: Tome 1

## GERMAN – III

**Course Code: FLG 311**

**Credit Units: 02**

### **Course Objective:**

To enable the students to converse, read and write in the language with the help of the basic rules of grammar, which will later help them to strengthen their language.

To give the students an insight into the culture, geography, political situation and economic opportunities available in Germany

### **Course Contents:**

#### **Module I: Modal verbs**

Modal verbs with conjugations and usage, Imparting the finer nuances of the language

#### **Module II: Information about Germany (ongoing)**

Information about Germany in the form of presentations or “Referat”– neighbors, states and capitals, important cities and towns and characteristic features of the same, and also a few other topics related to Germany.

#### **Module III: Dative case**

Dative case, comparison with accusative case, Dative case with the relevant articles  
Introduction to 3 different kinds of sentences – nominative, accusative and dative

#### **Module IV: Dative personal pronouns**

Nominative, accusative and dative pronouns in comparison

#### **Module V: Dative prepositions**

Dative preposition with their usage both theoretical and figurative use

#### **Module VI: Dialogues**

In the Restaurant,  
At the Tourist Information Office,  
A telephone conversation

#### **Module VII: Directions**

Names of the directions  
Asking and telling the directions with the help of a roadmap

#### **Module VIII: Conjunctions**

To assimilate the knowledge of the conjunctions learnt indirectly so far

**Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation I – Interaction/Conversation Practice

**Text & References:**

- Wolfgang Hieber, Lernziel Deutsch
- Hans-Heinrich Wangler, Sprachkurs Deutsch
- Schulz Griesbach, Deutsche Sprachlehre für Ausländer
- P.L Aneja, Deutsch Interessant- 1, 2 & 3
- Rosa-Maria Dallapiazza et al, Tangram Aktuell A1/1,2
- Braun, Nieder, Schmöe, Deutsch als Fremdsprache 1A, Grundkurs

## SPANISH – III

**Course Code:FLS 311**

**Credit Units: 02**

### **Course Objective:**

To enable students acquire knowledge of the Set/definite expressions (idiomatic expressions) in Spanish language and to handle some Spanish situations with ease.

### **Course Contents:**

#### **Module I**

Revision of earlier semester modules

Set expressions (idiomatic expressions) with the verb *Tener, Poner, Ir....*

Weather

#### **Module II**

Introduction to *Gustar...*and all its forms. Revision of *Gustar* and usage of it

#### **Module III**

Translation of Spanish-English; English-Spanish. Practice sentences.

How to ask for directions (using *estar*)

Introduction to IR + A + INFINITIVE FORM OF A VERB

#### **Module IV**

Simple conversation with help of texts and vocabulary

En el restaurante

En el instituto

En el aeropuerto

#### **Module V**

Reflexives

### **Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation, I – Interaction/Conversation Practice

**Text & References:**

- Español, En Directo I A
- Español Sin Fronteras -Nivel Elemental



## CHINESE – III

**Course Code: FLC 311**

**Credit Units: 02**

### **Course Objective:**

Foreign words are usually imported by translating the concept into Chinese, the emphasis is on the meaning rather than the sound. But the system runs into a problem because the underlying name of personal name is often obscure so they are almost always transcribed according to their pronunciation alone. The course aims at familiarizing the student with the basic aspects of speaking ability of Mandarin, the language of Mainland China. The course aims at training students in practical skills and nurturing them to interact with a Chinese person.

### **Course Contents:**

#### **Module I**

Drills, Dialogue practice, Observe picture and answer the question, Introduction of written characters, Practice reading aloud, Practice using the language both by speaking and by taking notes, Character writing and stroke order

#### **Module II**

Measure words, Position words e.g. inside, outside, middle, in front, behind, top, bottom, side, left, right, straight, Directional words – beibian, xibian, nanbian, dongbian, zhongjian, Our school and its different building locations, What game do you like? Difference between “hii” and “neng”, “keyi”.

#### **Module III**

Changing affirmative sentences to negative ones and vice versa, Human body parts, Not feeling well words e.g. ; fever, cold, stomach ache, head ache, Use of the modal particle “le”, Making a telephone call, Use of “jiu” and “cal” (Grammar portion), Automobiles e.g. Bus, train, boat, car, bike etc, Traveling, by train, by airplane, by bus, on the bike, by boat.. etc.

#### **Module IV**

The ordinal number “di”, “Mei” the demonstrative pronoun e.g. mei tian, mei nian etc, use of to enter to exit, Structural particle “de” (Compliment of degree), Going to the Park., Description about class schedule during a week in school, Grammar use of “li” and “cong”, Comprehension reading followed by questions.

#### **Module V**

Persuasion-Please don't smoke, Please speak slowly, Praise – This pictorial is very beautiful, Opposites e.g. Clean-Dirty, Little-More, Old-New, Young-Old, Easy-Difficult, Boy-Girl, Black-White, Big-Small, Slow-Fast ... etc, Talking about studies and classmates, Use of “it doesn't matter”, Enquiring about a student, description about study method, Grammar: Negation of a sentence with a verbal predicate.

### **Examination Scheme:**

<b>Components</b>	<b>CT1</b>	<b>CT2</b>	<b>C</b>	<b>I</b>	<b>V</b>	<b>A</b>
<b>Weightage (%)</b>	20	20	20	20	15	5

C – Project + Presentation

I – Interaction/Conversation Practice

**Text & References:**

- “Elementary Chinese Reader Part I, Part-2” Lesson 21-30

## DISSERTATION

**Course Code: MTS 455**

**Credit Units: 30**

**Course Objective:**

To give an in depth understanding of the research problem and to generate experimental expertise. The students will work in a R & D institutions / industries.

**Course Contents:**

**To carry out research project on specific problem for dissertation**

Dissertation of six months in a R&D institution or industry. The students will work on a project either under the joint guidance of a Professor/Scientist in that organization. The work after completion will be submitted to Amity Institute of Renewable and Alternative Energy(AIRAE) , which is a part of their M. Tech (Solar and Alternative Energy) degree programme of this Amity University Rajasthan.

**Examination Scheme:**

Project	: 60%
Presentation/Seminar	: 20%
Viva	: 20%
<b>Total</b>	<b>: 100%</b>