

Choice Based Credit System (CBCS)

UNIVERSITY OF DELHI

FACULTY OF SCIENCES

**UNDERGRADUATE PROGRAMME
(Courses effective from Academic Year 2015-16)**



SYLLABUS OF COURSES TO BE OFFERED
Core Courses, Elective Courses & Ability Enhancement Courses

Disclaimer: The CBCS syllabus is uploaded as given by the Faculty concerned to the Academic Council. The same has been approved as it is by the Academic Council on 13.7.2015 and Executive Council on 14.7.2015. Any query may kindly be addressed to the concerned Faculty.

Undergraduate Programme Secretariat

Preamble

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters.

The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching-learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students. Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades.

The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS):

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

- 1. Core Course:** A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.
- 2. Elective Course:** Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.
 - 2.1 Discipline Specific Elective (DSE) Course:** Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).
 - 2.2 Dissertation/Project:** An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.
 - 2.3 Generic Elective (GE) Course:** An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.
- 3. Ability Enhancement Courses (AEC)/Competency Improvement Courses/Skill Development Courses/Foundation Course:** The Ability Enhancement (AE) Courses may be of two kinds: AE Compulsory Course (AECC) and AE Elective Course (AEEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement. They ((i) Environmental Science, (ii) English/MIL Communication) are mandatory for all disciplines. AEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.
 - 3.1 AE Compulsory Course (AECC):** Environmental Science, English Communication/MIL Communication.
 - 3.2 AE Elective Course (AEEC):** These courses may be chosen from a pool of courses designed to provide value-based and/or skill-based instruction.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

Details of Courses Under Undergraduate Programme (B.Sc.)

Course	*Credits	
=====		
	Theory+ Practical	Theory+Tutorials
<u>I. Core Course</u>	12X4= 48	12X5=60
(12 Papers)		
04 Courses from each of the		
03 disciplines of choice		
Core Course Practical / Tutorial*	12X2=24	12X1=12
(12 Practical/ Tutorials*)		
04 Courses from each of the		
03 Disciplines of choice		
 <u>II. Elective Course</u>	 6x4=24	 6X5=30
(6 Papers)		
Two papers from each discipline of choice		
including paper of interdisciplinary nature.		
Elective Course Practical / Tutorials*	6 X 2=12	6X1=6
(6 Practical / Tutorials*)		
Two Papers from each discipline of choice		
including paper of interdisciplinary nature		
<ul style="list-style-type: none"> • Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester 		
 <u>III. Ability Enhancement Courses</u>		
1. Ability Enhancement Compulsory	2 X 2=4	2X2=4
(2 Papers of 2 credits each)		
Environmental Science		
English/MIL Communication		
2. Ability Enhancement Elective	4 X 2=8	4 X 2=8
(Skill Based)		
(4 Papers of 2 credits each)		
	_____	_____
	Total credit= 120	Total credit= 120
Institute should evolve a system/policy	about	ECA/ General
Interest/Hobby/Sports/NCC/NSS/related courses on its own.		
*wherever there is practical there will be no tutorials and vice -versa		

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Eqtg'r crgtu'Ggevt qpleu' *E t g f k < 28 ' g c e j + ' * E R ' 3 / 6 #:

1. Network Analysis and Analog Electronics (4) + Lab (4)
2. Linear and Digital Integrated Circuits (4) + Lab (4)
3. Communication Electronics (4) + Lab (4)
4. Microprocessor and microcontrollers (4) + Lab (4)

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F l e k r d p g ' U r g e l l e ' G g e v k g ' r c r g t u ' * E t g f k < 28 ' g c e j + ' * F U G ' 3 . ' F U G ' 4 #: Choose 2

Odd semester Options:

1. Semiconductor Devices Fabrication (4) + Lab (4)
2. Electronic Instrumentation (4) + Lab (4)
3. Digital Signal Processing (4) + Lab (4)

Even semester Options:

4. Verilog and FPGA based system Design (4) + Lab (4)
5. Photonic devices and Power Electronics (4) + Lab (4)
6. Antenna Theory and wireless Network (5) + Tutorial (1)
7. Dissertation

Note: Universities may include more options or delete some from this list

U n d r G p j c p e g o g p v ' E q w t u g ' * c p { ' h q w t + ' * E t g f k < 24 ' g c e j + ' / ' U G E ' 3 ' t q ' U G E ' 6 "

1. Computational Physics Skills
2. Electrical circuits and Network Skills
3. Renewable Energy and Energy harvesting
4. Technical Drawing
5. Applied Optics
6. Weather Forecasting

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***Et gf ku'Vj gqt{/26.'Rtcevlecni/24+'''' " " " " "**

Vj gqt{ <82'Ngewt gu'

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O gcwut go gpw< Accuracy and precision. Significant figures. Error and uncertainty analysis. Shielding and grounding. Electromagnetic Interference. ''' " ***5'Ngewt gu+**

Dcule'O gcwut go gpv'kput wo gpw< DC measurement-ammeter, voltmeter, ohm meter, AC measurement, Digital voltmeter systems (integrating and non-integrating). Digital Multimeter; Block diagram principle of measurement of I, V, C. Accuracy and resolution of measurement. **O gcwut go gpv'qhi'ko r gfcpeg/** A.C. bridges, Measurement of Self Inductance (Anderson's bridge), Measurement of Capacitance (De Sauty's bridge), Measurement of frequency (Wien's bridge). ***34'Ngewt gu+''**

Rqy gt'twr riq <Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators (78XX and 79XX), Line and load regulation, Short circuit protection. Idea of switched mode power supply (SMPS) & uninterrupter power supply(UPS). ***6'Ngewt gu+''**

Queknueqr g: Block Diagram, CRT, Vertical Deflection, Horizontal Deflection. Screens for CRT, Oscilloscope probes, measurement of voltage, frequency and phase by Oscilloscope. Digital Storage Oscilloscope. LCD display for instruments. ***32'Ngewt gu+''**

O wnkldt cvqtu'*E'777+: Block diagram, Astable & Monostable multivibrator circuits.

Rj cug'Nqengf 'Nqqr '*RNN+: Basic Principles, Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor), lock and capture. Basic idea of PLL IC (565 or 4046). Lock-in-amplifier (qualitative only). ***33'Ngewt gu+''**

Ui pcnI gpgt cvqtu Function generator, Pulse Generator(qualitative only). ***5'Ngewt gu+''**

Xlt wcn'kput wo gpvcvqp: Introduction, Interfacing techniques (RS 232, GPIB, USB). Idea about Audrino microcontroller & interfacing software like lab View). **(7 Ngewt gu+**

Vt c puf wegt u Classification of transducers, Basic requirement/characteristics of transducers, Active and Passive transducers, Resistive (Potentiometer- Theory, temperature compensation and applications), Capacitive (variable air gap type), Inductive (LVDT) and piezoelectric transducers. Measurement of temperature(RTD, semiconductor IC sensors), Light transducers (photo resistors & photovoltaic cells). ***34'Ngewt gu+**

Tghgt gpeg'Dqqm<'

- W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
- E.O. Doebelin, Measurement Systems: Application and Design, McGraw Hill Book - fifth Edition (2003).

- David A. Bell, Electronic Devices and Circuits, Oxford University Press (2015).
- Alan S. Morris, "Measurement and Instrumentation Principles", Elsevier (Butterworth Heinmann-2008).
- S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998).

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NCD'"
82'Rgt kqf u'

AT LEAST 06 EXPERIMENTS FROM THE FOLLOWING

1. Measurement of resistance by Wheatstone bridge and measurement of bridge sensitivity.
2. Measurement of Capacitance by De Sauty's bridge
3. To determine the Characteristics of resistance transducer - Strain Gauge (Measurement of Strain using half and full bridge.)
4. To determine the Characteristics of LVDT.
5. To determine the Characteristics of Thermistors and RTD.
6. Measurement of temperature by Thermocouples.
7. Design a regulated power supply of given rating (5 V or 9V).
8. To design an Astable Multivibrator of given specification using IC 555 Timer.
9. To design a Monostable Multivibrator of given specification using IC 555 Timer.
10. To design and study the Sample and Hold Circuit.
11. To plot the frequency response of a microphone.
 1. Glow an LED via USB port of PC.
12. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

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- W.D. Cooper and A. D. Helfrick, Electronic Instrumentation and Measurement Techniques, Prentice Hall (2005).
- David A. Bell, Electronic Instrumentation & Measurements, Prentice Hall (2013)
- S. Rangan, G. R. Sarma and V. S. Mani, Instrumentation Devices and Systems, Tata Mcgraw Hill (1998).
- Basic Electronics:A text lab manual, P.B.Zbar, A.P.Malvino, M.A.Miller, 1990, Mc-Graw Hill

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*Et gf ku'Vj gqt {/26.'Rtcevlecn/24+' " " " " "

Vj gqt { <82'Ngewt gu'

Fkætgv/Vlo g'Ui pcn'cpf "U{wgo u'Classification of Signals, Transformations of the Independent Variable, Periodic and Aperiodic Signals, Energy and Power Signals, Even and Odd Signals, Discrete-Time Systems, System Properties. Impulse Response, Convolution Sum; Graphical Method; Analytical Method, Properties of Convolution; Commutative; Associative; Distributive; Shift; Sum Property System Response to Periodic Inputs, Relationship Between LTI System Properties and the Impulse Response; Causality; Stability; Invertibility, Unit Step Response. *32'Ngewt gu+

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Fkætgv/Vlo g'Hqwtlgt "Vtcpuht o <'Fourier Transform Representation of Aperiodic Discrete-Time Signals, Periodicity of DTFT, Properties; Linearity; Time Shifting; Frequency Shifting; Differencing in Time Domain; Differentiation in Frequency Domain; Convolution Property. **Vj g'z/Vtcpuht o <'**Bilateral (Two-Sided) z-Transform, Inverse z-Transform, Relationship Between z-Transform and Discrete-Time Fourier Transform, z-plane, Region-of-Convergence; Properties of ROC, Properties; Time Reversal; Differentiation in the z-Domain; Power Series Expansion Method (or Long Division Method); Analysis and Characterization of LTI Systems; Transfer Function and Difference-Equation System. Solving Difference Equations. *37'Ngewt gu+

Hngt 'Eqpegr u<'Phase Delay and Group delay, Zero-Phase Filter, Linear-Phase Filter, Simple FIR Digital Filters, Simple IIR Digital Filters, All pass Filters, Averaging Filters, Notch Filters. ***7'Ngewt gu+

Fkætgv'Hqwtlgt "Vtcpuht o <'Frequency Domain Sampling (Sampling of DTFT), The Discrete Fourier Transform (DFT) and its Inverse, DFT as a Linear transformation, Properties; Periodicity; Linearity; Circular Time Shifting; Circular Frequency Shifting; Circular Time Reversal; Multiplication Property; Parseval's Relation, Linear Convolution Using the DFT (Linear Convolution Using Circular Convolution), Circular Convolution as Linear Convolution with aliasing. *32'Ngewt gu+'
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Hcu'Hqwtlgt "Vtcpuht o <'Direct Computation of the DFT, Symmetry and Periodicity Properties of the Twiddle factor (WN), Radix-2 FFT Algorithms; Decimation-In-Time (DIT) FFT Algorithm; Decimation-In-Frequency (DIF) FFT Algorithm, Inverse DFT Using FFT Algorithms. *7'Ngewt gu+'
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Tgerk cvlqp'qh'F li kcn'Hngt u<'Non Recursive and Recursive Structures, Canonic and Non Canonic Structures, Equivalent Structures (Transposed Structure), FIR Filter structures; Direct-Form; Cascade-Form; Basic structures for IIR systems; Direct-Form I.

Hplsg"ko r wng"Tur qpug"Fl i kcn'Hngt <'Advantages and Disadvantages of Digital Filters, Types of Digital Filters: FIR and IIR Filters; Difference Between FIR and IIR

Filters, Desirability of Linear-Phase Filters, Frequency Response of Linear-Phase FIR Filters, Impulse Responses of Ideal Filters, Windowing Method; Rectangular; Triangular; Kaiser Window, FIR Digital Differentiators.

Infinite Impulse Response Digital Filter: Design of IIR Filters from Analog Filters, IIR Filter Design by Approximation of Derivatives, Backward Difference Algorithm, Impulse Invariance Method. **(15 Lectures)**

Reference Books:

- Digital Signal Processing, Tarun Kumar Rawat, 2015, Oxford University Press, India
- Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
- Principles of Signal Processing and Linear Systems, B.P. Lathi, 2009, 1st Edn. Oxford University Press.
- Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
- Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.

PRACTICAL-DSE LAB: DIGITAL SIGNAL PROCESSING LAB

60 Periods

At least 06 experiments from the following using Scilab. Introduction to Numerical computation software Scilab be introduced in the lab.

1. Write a program to generate and plot the following sequences: (a) Unit sample sequence $\delta(n)$, (b) unit step sequence $u(n)$, (c) ramp sequence $r(n)$, (d) real valued exponential sequence $x(n) = (0.8)^n u(n)$ for $0 \leq n \leq 50$.
2. Write a program to compute the convolution sum of a rectangle signal (or gate function) with itself for $N = 5$

$$x(n) = \text{rect}\left(\frac{n}{2N}\right) = \Pi\left(\frac{n}{2N}\right) = \begin{cases} 1 & -N \leq n \leq N \\ 0 & \text{otherwise} \end{cases}$$
3. An LTI system is specified by the difference equation

$$y(n) = 0.8y(n-1) + x(n)$$
 - (a) Determine $H(e^{j\omega})$
 - (b) Calculate and plot the steady state response $y_{ss}(n)$ to

$$x(n) = \cos(0.5\pi n)u(n)$$
4. Given a casual system

$$y(n) = 0.9y(n-1) + x(n)$$
 - (a) Find $H(z)$ and sketch its pole-zero plot
 - (b) Plot the frequency response $|H(e^{j\omega})|$ and $\angle H(e^{j\omega})$

5. Design a digital filter to eliminate the lower frequency sinusoid of $x(t) = \sin 7t + \sin 200t$. The sampling frequency is $f_s = 500 \text{ Hz}$. Plot its pole zero diagram, magnitude response, input and output of the filter.

6. Let $x(n)$ be a 4-point sequence:

$$x(n) = \begin{matrix} \{1,1,1,1\} \\ \uparrow \\ \end{matrix} = \begin{cases} 1 & 0 \leq n \leq 3 \\ 0 & \text{otherwise} \end{cases}$$

Compute the DTFT $X(e^{j\omega})$ and plot its magnitude

- (a) Compute and plot the 4 point DFT of $x(n)$
 (b) Compute and plot the 8 point DFT of $x(n)$ (by appending 4 zeros)
 (c) Compute and plot the 16 point DFT of $x(n)$ (by appending 12 zeros)
7. Let $x(n)$ and $h(n)$ be the two 4-point sequences,

$$x(n) = \begin{matrix} \{1,2,2,1\} \\ \uparrow \\ \end{matrix}$$

$$h(n) = \begin{matrix} \{1, -1, -1, 1\} \\ \uparrow \\ \end{matrix}$$

Write a program to compute their linear convolution using circular convolution.

8. Using a rectangular window, design a FIR low-pass filter with a pass-band gain of unity, cut off frequency of 1000 Hz and working at a sampling frequency of 5 KHz. Take the length of the impulse response as 17.

9. Design an FIR filter to meet the following specifications:

passband edge $F_p = 2 \text{ KHz}$

stopband edge $F_s = 5 \text{ KHz}$

Passband attenuation $A_p = 2 \text{ dB}$

Stopband attenuation $A_s = 42 \text{ dB}$

Sampling frequency $F_s = 20 \text{ KHz}$

10. The frequency response of a linear phase digital differentiator is given by

$$H_d(e^{j\omega}) = j\omega e^{-j\tau\omega} \quad |\omega| \leq \pi$$

Using a Hamming window of length $M = 21$, design a digital FIR differentiator. Plot the amplitude response.

Reference Books:

- Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press, India.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press

- Fundamentals of Digital Signal processing using MATLAB, R.J. Schilling and S.L. Harris, 2005, Cengage Learning.
 - Getting started with MATLAB, Rudra Pratap, 2010, Oxford University Press.
 - Digital Signal Processing, S. K. Mitra, McGraw Hill, India.
 - Fundamentals of signals and systems, P.D. Cha and J.I. Molinder, 2007, Cambridge University Press.
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ELECTRONICS-DSE: VERILOG AND FPGA BASED SYSTEM DESIGN

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

Digital logic design flow. Review of combinational circuits. Combinational building blocks: multiplexers, demultiplexers, decoders, encoders and adder circuits. Review of sequential circuit elements: flip-flop, latch and register. Finite state machines: Mealy and Moore. Other sequential circuits: shift registers and counters. FSM (Finite State Machine with Datapath): design and analysis. Microprogrammed control. Memory basics and timing. Programmable Logic devices. **(20 lectures)**

Evolution of Programmable logic devices. PAL, PLA and GAL. CPLD and FPGA architectures. Placement and routing. Logic cell structure, Programmable interconnects, Logic blocks and I/O Ports. Clock distribution in FPGA. Timing issues in FPGA design. Boundary scan. **(20 lectures)**

Verilog HDL: Introduction to HDL. Verilog primitive operators and structural Verilog Behavioral Verilog. Design verification. Modeling of combinational & sequential circuits (including FSM and FSM) with Verilog Design examples in Verilog. **(20 lectures)**

Reference Books:

- LizyKurien and Charles Roth. *Principles of Digital Systems Design and VHDL*. Cengage Publishing. ISBN-13: 978-8131505748
 - Ming-Bo Lin. *Digital System Designs and Practices: Using Verilog HDL and FPGAs*. Wiley India Pvt Ltd. ISBN-13: 978-8126536948
 - Zainalabedin Navabi. *Verilog Digital System Design*. TMH; 2nd edition. ISBN-13: 978-0070252219
 - Wayne Wolf. *FPGA Based System Design*. Pearson Education.
 - S. K. Mitra, Digital Signal processing, McGraw Hill, 1998
 - VLSI design, Debaprasad Das, 2nd Edition, 2015, Oxford University Press.
 - D.J. Laja and S. Sapatnekar, Designing Digital Computer Systems with Verilog, Cambridge University Press, 2015.
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PRACTICALS-DSE LAB: VERILOG AND FPGA LAB

60 Periods

AT LEAST 08 EXPERIMENTS FROM FOLLOWING.

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Design and simulation of a 4 bit Adder.
5. Multiplexer (4x1) and Demultiplexer using logic gates.
6. Decoder and Encoder using logic gates.
7. Clocked D, JK and T Flip flops (with Reset inputs)
8. 3-bit Ripple counter
9. To design and study switching circuits (LED blink shift)
10. To design traffic light controller.
11. To interface a keyboard
12. To interface a LCD using FPGA
13. To interface multiplexed seven segment display.
14. To interface a stepper motor and DC motor.
15. To interface ADC 0804.

Reference Books

- W. Wolf, FPGA- based System Design, Pearson, 2004
 - U. Meyer Baese, Digital Signal Processing with FPGAs, Springer, 2004
 - S. Palnitkar, Verilog HDL– A Guide to Digital Design & Synthesis, Pearson, 2003
 - Verilog HDL primer- J. Bhasker. BSP, 2003 II edition
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ELECTRONICS- DSE: PHOTONIC DEVICES AND POWER ELECTRONICS

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

UNIT-I: PHOTONIC DEVICES

Classification of photonic devices. Interaction of radiation and matter, Radiative transition and optical absorption. Light Emitting Diodes- Construction, materials and operation. Semiconductor Laser- Condition for amplification, laser cavity, hetero-structure and quantum well devices. Charge carrier and photon confinement, line shape function. Threshold current. Laser diode. **(12 Lectures)**

Photodetectors: Photoconductor. Photodiodes (p-i-n, avalanche) and Photo transistors, quantum efficiency and responsivity. Photomultiplier tube. **(5 Lectures)**

Solar Cell: Construction, working and characteristics **(2 Lectures)**

LCD Displays: Types of liquid crystals, Principle of Liquid Crystal Displays, applications, advantages over LED displays. **(4 Lectures)**

Introduction to Fiber Optics: Evolution of fiber optic system- Element of an Optical Fiber Transmission link- Ray Optics-Optical Fiber Modes and Configurations -Mode theory of Circular Wave guides- Overview of Modes-Key Modal concepts- Linearly Polarized Modes -Single Mode Fibers-Graded Index fiber structure. **(13 Lectures)**

UNIT-II: POWER ELECTRONICS

Power Devices: Need for semiconductor power devices, Power MOSFET (Qualitative). Introduction to family of thyristors. Silicon Controlled Rectifier (SCR)- structure, I-V characteristics, Turn-On and Turn-Off characteristics, ratings, Gate-triggering circuits. Diac and Triac- Basic structure, working and V-I characteristics. Application of Diac as a triggering device for Triac. **(10 Lectures)**

Insulated Gate Bipolar Transistors (IGBT): Basic structure, I-V Characteristics, switching characteristics, device limitations and safe operating area (SOA). **(2 Lectures)**

Applications of SCR: Phase controlled rectification, AC voltage control using SCR and Triac as a switch. Power Invertors- Need for commutating circuits and their various types, dc link invertors, Parallel capacitor commutated invertors, Series Invertor, limitations and its improved versions, bridge invertors. **(12 Lectures)**

Reference Books:

- Optoelectronics, J. Wilson and J.F.B. Hawkes, Prentice Hall India (1996)
 - Optoelectronics and Photonics, S.O. Kasap, Pearson Education (2009)
 - Electronic Devices and Circuits, David A. Bell, 2015, Oxford University Press.
 - Introduction to fiber optics, AK Ghatak & K Thyagarajan, Cambridge University Press (1998)
 - Power Electronics, P.C. Sen, Tata McGraw Hill
 - Power Electronics, M.D. Singh & K.B. Khanchandani, Tata McGraw Hill
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PRACTICALS -DSE-1 LAB: PHOTONIC DEVICES AND POWER ELECTRONICS LAB

60 Periods

AT LEAST 06 EXPERIMENTS FROM THE FOLLOWING

1. To determine wavelength of sodium light using Michelson's Interferometer.
2. Diffraction experiments using a laser.
3. Study of Electro-optic Effect.
4. To determine characteristics of (a) LEDs, (b) Photo voltaic cell and (c) Photo diode.
5. To study the Characteristics of LDR and Photodiode with (i) Variable Illumination intensity, and (ii) Linear Displacement of source.
6. To measure the numerical aperture of an optical fiber.
7. Output and transfer characteristics of a power MOSFET.
8. Study of I-V characteristics of SCR
9. SCR as a half wave and full wave rectifiers with R and RL loads.
10. AC voltage controller using TRIAC with UJT triggering.
11. Study of I-V characteristics of DIAC
12. Study of I-V characteristics of TRIAC

Reference Books:

- Introduction to fiber optics, AK Ghatak and K Thyagarajan, Cambridge University Press (1998)
 - Power Electronics, M.D. Singh & K.B. Khanchandani, Tata McGraw Hill
 - Power Electronics Circuits, Devices & Applications, 3rd Edn., M.H.Rashid, Pearson Education
 - A Textbook of Electrical Technology, Vol-II, B.L.Thareja, A.K.Thareja, S.Chand.
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ELECTRONICS-DSE: ANTENNA THEORY AND WIRELESS NETWORKS

(Credits: Theory-05, Tutorial-01)

Theory: 75 Lectures

ANTENNA THEORY:

Introduction: Antenna as an element of wireless communication system, Antenna radiation mechanism, Types of Antennas, Fundamentals of EMFT: Maxwell's equations and their applications to antennas. **(7 Lectures)**

Antenna Parameters: Antenna parameters: Radiation pattern (polarization patterns, Field and Phase patterns), Field regions around antenna, Radiation intensity, Beam width, Gain, Directivity, Polarization, Bandwidth, Efficiency and Antenna temperature.

(9 Lectures)

Antenna as a Transmitter/Receiver: Effective Height and Aperture, Power delivered to antenna, Input impedance. Radiation from an infinitesimal small current element, Radiation from an elementary dipole (Hertzian dipole), Reactive, Induction and Radiation fields, Power density and radiation resistance for small current element and half wave dipole antenna. **(12 Lectures)**

Radiating wire Structures (Qualitative idea only): Monopole, Dipole, Folded dipole, Loop antenna and Biconical broadband Antenna. Basics of Patch Antenna and its design. Examples of Patch antenna like bowtie, sectoral, fractal, etc. **(6 Lectures)**

Propagation of Radio Waves: Different modes of propagation: Ground waves, Space waves, Space Wave propagation over flat and curved earth, Optical and Radio Horizons, Surface Waves and Troposphere waves, Ionosphere, Wave propagation in the Ionosphere. Critical Frequency, Maximum usable frequency (MUF), Skips distance. Virtual height. Radio noise of terrestrial and extraterrestrial origin. Elementary idea of propagation of waves used in terrestrial mobile communications. **(9 Lectures)**

WIRELESS NETWORKS:

Introduction: History of wireless communication, Wireless Generation and Standards, Cellular and Wireless Systems, Current Wireless Systems, Cellular Telephone Systems, Wide Area Wireless Data Services, Broadband Wireless Access, Satellite Networks, Examples of Wireless Communication Systems. Idea about Global Mobile communication system. **(10 Lectures)**

Modern Wireless Communication Systems: Second Generation (2G) Cellular Networks, Third Generation (3G) Wireless Networks, Wireless Local Loop (WLL), Wireless Local Area Networks (WLANs), Bluetooth and Personal Area Networks (PANs). Idea about Wi-Fi, 4G and LTE, and 5G. **(10 Lectures)**

Cellular Concept and System Design Fundamentals: Cellular Concept and Cellular System Fundamentals, Frequency Reuse, Channel Assignment Strategies, Handoff strategies, Interference and System Capacity, Trunking and Grade of Service. Improving Coverage & Capacity in Cellular Systems. Cell Splitting and Sectoring. Cellular Systems design Considerations (Qualitative idea only). **(12 Lectures)**

Reference Books:

- Ballanis, Antenna Theory, John Wiley & Sons, (2003) 2nd Ed.
- Jordan and Balmain, E. C., Electro Magnetic Waves and Radiating Systems, PHI, 1968 Reprint (2003) 3rd Ed.
- Andrea Goldsmith, Wirelerrs communications, (2015) Cambridge University Press
- D. Tse and P. Viswanathan, Fundamentals of Wireless Communication, (2014) Cambridge University Press
- Wireless communication and Networks, Upena Dala, 2015, Oxford University Press.

- Haykin S. & Moher M., Modern Wireless Communication, Pearson, (2005) 3rd Ed.
 - Lee, William C.Y., Mobile Communciation Design and Fundamentals, (1999) 4th Ed
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Skill Enhancement Course (any four) (Credit: 02 each)- SEC1 to SEC4

PHYSICS WORKSHOP SKILL

30 Lectures

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode

Introduction: Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc. **(4 Lectures)**

Mechanical Skill: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothing of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet. **(10 Lectures)**

Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay. **(10 Lectures)**

Introduction to prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment. **(6 Lectures)**

Reference Books:

- A text book in Electrical Technology - B L Theraja – S. Chand and Company.
 - Performance and design of AC machines – M.G. Say, ELBS Edn.
 - Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
 - Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
 - New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]
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COMPUTATIONAL PHYSICS

Theory: 30 Lectures

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics and Science.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics/science problems*
- *Course will consist of hands on training on the Problem solving on Computers.*

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of $\sin(x)$ as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. **(4 Lectures)**

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems. **(5 Lectures)**

Control Statements: Types of Logic(Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic **IF**, Block **IF**, Nested Block **IF**, **SELECT CASE** and **ELSE IF** Ladder statements), Looping Statements (**DO-CONTINUE**, **DO-ENDDO**, **DO-WHILE**, Implied and Nested **DO** Loops), Jumping Statements (Unconditional **GOTO**, Computed **GOTO**, Assigned **GOTO**) Subscripted Variables (Arrays: Types of Arrays, **DIMENSION** Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), **RETURN**, **CALL**, **COMMON** and **EQUIVALENCE** Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using $\exp(x)$ series evaluated at $x=1$ **(6 Lectures)**

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages.
Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. **(6 Lectures)**

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

(9 Lectures)

Reference Books:

- Introduction to Numerical Analysis, S.S.Sastry, 5th Edn.,2012, PHI Learning
 - Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
 - LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
 - Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
 - Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
 - Computational Physics: An Introduction, R. C. Verma, etal. New Age International Publishers, New Delhi(1999)
 - Elementary Numerical Analysis, K.E.Atkinson,3rd Ed n., 2007, Wiley India Edition.
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ELECTRICAL CIRCUITS AND NETWORK SKILLS

Theory: 30 Lectures

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. **(3 Lectures)**

Electrical Circuits: Basic electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. **(4 Lectures)**

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **(4 Lectures)**

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. **(3 Lectures)**

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. **(4 Lectures)**

Solid-State Devices: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **(3 Lectures)**

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Relay protection device. **(4 Lectures)**

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, and solder. Preparation of extension board. **(5 Lectures)**

Reference Books:

- Electrical Circuits, K.A. Smith and R.E. Alley, 2014, Cambridge University Press
- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja

- Performance and design of AC machines - M G Say ELBS Edn.
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RENEWABLE ENERGY AND ENERGY HARVESTING

Theory:30 Lectures

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **(3 Lectures)**

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **(6 Lectures)**

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. **(3 Lectures)**

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. **(3 Lectures)**

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. **(2 Lectures)**

Geothermal Energy: Geothermal Resources, Geothermal Technologies. **(2 Lectures)**

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. **(2 Lectures)**

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power **(4 Lectures)**

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications **(2 Lectures)**

Carbon captured technologies, cell, batteries, power consumption **(2 Lectures)**

Environmental issues and Renewable sources of energy, sustainability. **(1 Lecture)**

Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

- Non-conventional energy sources, B.H. Khan, McGraw Hill
 - Solar energy, Suhas P Sukhative, Tata McGraw - Hill Publishing Company Ltd.
 - Renewable Energy, Power for a sustainable future, Godfrey Boyle, 3rd Edn., 2012, Oxford University Press.
 - Renewable Energy, 3rd Edition,
 - Solar Energy: Resource Assesment Handbook, P Jayakumar, 2009
 - J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
 - http://en.wikipedia.org/wiki/Renewable_energy
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TECHNICAL DRAWING

Theory: 30 Lectures

Introduction: Drafting Instruments and their uses. lettering: construction and uses of various scales: dimensioning as per I.S.I. 696-1972. Engineering Curves: Parabola: hyperbola: ellipse: cycloids, involute: spiral: helix and loci of points of simple moving mechanism. 2D geometrical construction. Representation of 3D objects. Principles of projections. **(4 Lectures)**

Projections: Straight lines, planes and solids. Development of surfaces of right and oblique solids. Section of solids. **(6 Lectures)**

Object Projections: Orthographic projection. Interpenetration and intersection of solids. Isometric and oblique parallel projection of solids. **(4 Lectures)**

CAD Drawing: Introduction to CAD and Auto CAD, precision drawing and drawing aids, Geometric shapes, Demonstrating CAD- specific skills (graphical user interface. Create, retrieve, edit, and use symbol libraries. Use inquiry commands to extract drawing data). Control entity properties. Demonstrating basic skills to produce 2-D and 3-D drawings. 3D modeling with Auto CAD (surfaces and solids), 3D modeling with sketch up, annotating in Auto CAD with text and hatching, layers, templates and design center, advanced plotting (layouts, viewports), office standards, dimensioning, internet and collaboration, Blocks, Drafting symbols, attributes, extracting data. basic printing, editing tools, Plot/Print drawing to appropriate scale. **(16 Lectures)**

Reference Books:

- Engineering Drawing, N.S. Parthasarathy and Vele Murali, 1st Edition, 2015, Oxford University Press
- Engineering Graphic, K. Venugopal, and V. Raja Prabhu, New Age International
- AutoCAD 2014 & AutoCAD 2014/Donnie Gladfelter/Sybex/ISBN:978-1-118-57510-9
- Architectural Design with Sketchup/Alexander Schreyer/John Wiley & Sons/ISBN: 978-1-118-12309-6

APPLIED OPTICS**THEORY: 30 Lectures**

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

<p>(i) Sources and Detectors (9 Periods) Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.</p>
<p>Experiments on Lasers:</p> <ol style="list-style-type: none"> Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser. To find the polarization angle of laser light using polarizer and analyzer Thermal expansion of quartz using laser <p>Experiments on Semiconductor Sources and Detectors:</p> <ol style="list-style-type: none"> V-I characteristics of LED Study the characteristics of solid state laser Study the characteristics of LDR Photovoltaic Cell Characteristics of IR sensor
<p>(ii) Fourier Optics (6 Periods) Concept of Spatial frequency filtering, Fourier transforming property of a thin lens</p>
<p>Experiments on Fourier Optics:</p> <ol style="list-style-type: none"> Fourier optic and image processing <ol style="list-style-type: none"> Optical image addition/subtraction Optical image differentiation Fourier optical filtering Construction of an optical 4f system Fourier Transform Spectroscopy Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science. <p>Experiment: To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier</p>

transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.
(iii) Holography (6 Periods) Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition.
Experiments on Holography and interferometry: <ol style="list-style-type: none"> 1. Recording and reconstructing holograms 2. Constructing a Michelson interferometer or a Fabry Perot interferometer 3. Measuring the refractive index of air 4. Constructing a Sagnac interferometer 5. Constructing a Mach-Zehnder interferometer 6. White light Hologram
(iv) Photonics: Fibre Optics (9 Periods) Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating
Experiments on Photonics: Fibre Optics <ol style="list-style-type: none"> a. To measure the numerical aperture of an optical fibre b. To study the variation of the bending loss in a multimode fibre c. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern d. To measure the near field intensity profile of a fibre and study its refractive index profile e. To determine the power loss at a splice between two multimode fibre

Reference Books:

- LASERS: Fundamentals & applications, K.Thyagrajan and A.K.Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Optical Electronics, Ajoy Ghatak and K. Thyagarajan, 2011, Cambridge University Press
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.

WEATHER FORECASTING

Theory: 30 Lectures

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques

Introduction to atmosphere: Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics. **(9 Periods)**

Measuring the weather: Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

(4 Periods)

Weather systems: Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes.

(3 Periods)

Climate and Climate Change: Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

(6 Periods)

Basics of weather forecasting: Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

(8 Periods)

Demonstrations and Experiments:

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:
 - (a) To calculate the sunniest time of the year.
 - (b) To study the variation of rainfall amount and intensity by wind direction.
 - (c) To observe the sunniest/driest day of the week.
 - (d) To examine the maximum and minimum temperature throughout the year.
 - (e) To evaluate the relative humidity of the day.
 - (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non aviation)

Reference books:

1. Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
 2. The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.
 3. Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
 4. Text Book of Agro meteorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur
 5. Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.
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