DEFENCE RESEARCH & DEVELOPMENT ORGANISATION (DRDO)
GOVT. OF INDIA – MINISTRY OF DEFENCE

DEFENCE ELECTRONICS APPLICATIONS LABORATORY
Raipur Road, Dehradun – 248001
Phone: 0135-2787256, Fax: 0135-2787256

Dated: 26th May, 2017

CERTIFICATE

This is to certify that **Mr. Deepak Kumar**, a student of **Master of Technology (Microwave Electronics)** from **Department of Electronic Science, University of Delhi South Campus (UDSC)** under class **Roll No. 3663** for the session 2015-2017, has completed the **Dissertation** entitled **"Design of 100 Watt Ku-band Power Amplifier"** as an M. Tech. trainee at **Defence Electronics Applications Laboratory (DEAL), DRDO, Dehradun**, during the period 28th Dec 2016 to 26th May 2017. The Dissertation work has been completed under the supervision of **Sh. Rajendra Singh**, Scientist-'F'.

He has done an excellent job and was sincere during his training. He was always enthusiastic to learn, implement and solving problem at hand.

for

Ashok Kumar, Sc-G
Group Director
Millimeter Wave Systems Gp.
DEAL, DRDO

भारत सरकार
अंतरिक्ष विभाग
अंतरिक्ष उपयोग केन्द्र
आंबावाडी विस्तार डाक घर,
अहमदाबाद-380 015. (भारत)
दूरभाष : +91-79-26913050, 26913060
साईट : www.sac.isro.gov.in/www.sac.gov.in

Government of India
Department of Space
SPACE APPLICATIONS CENTRE
Ambawadi Vistar P.O.
Ahmedabad - 380 015. (INDIA)
Telephone : +91-79-26913050, 26913060
website : www.sac.isro.gov.in/www.sac.gov.in

May 25, 2017

CERTIFICATE OF PRACTICAL TRAINING

Name of the student : SAGAR SINGHAL

Name of the institution : UNIVERSITY OF DELHI, SOUTH CAMPUS
NEW DELHI

Period of training : 02/01/2017 to 25/05/2017

Name of the division
where training was taken : MSAD/ASG

DETAILS OF TRAINING

"DESIGN AND DEVELOPMENT OF X BAND DUAL POLARIZED WIDEBAND MULTILAYER APERTURE COUPLED MICROSTRIP PATCH ARRAY ANTENNA"

PROFICIENCY SHOWN BY THE CANDIDATE

Attendance : REGULAR

Conduct : VERY GOOD

Practical ability : He has good proficiency in HFSS. He is sincere and hardworking.

(J RAVISANKAR)
HEAD, HRDD

भारत सरकार
अंतरिक्ष विभाग
अंतरिक्ष उपयोग केन्द्र
आंबावाडी विस्तार डाक घर,
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Government of India
Department of Space
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Ahmedabad - 380 015. (INDIA)
Telephone : +91-79-26913050, 26913060
website : www.sac.isro.gov.in/www.sac.gov.in

May 25, 2017

CERTIFICATE OF PRACTICAL TRAINING

Name of the student : JATIN SINGH GAUTAM

Name of the institution : UNIVERSITY OF DELHI, SOUTH CAMPUS

Period of training : 04/01/2017 to 25/05/2017

Name of the division where training was taken : LMDD/MEG/ESSA

DETAILS OF TRAINING

"DESIGN AND CHARACTERIZATION OF LEAKY SURFACE ACOUSTIC WAVE(SAW) RESONATOR"

PROFICIENCY SHOWN BY THE CANDIDATE

Attendance : REGULAR

Conduct : VERY GOOD

Practical ability : He has good proficiency in Matlab. He is sincere and hardworking.

(J RAVISANKAR)
HEAD, HRDD

DEPARTMENT OF ELECTRONIC SCIENCE

University of Delhi South Campus

Benito Juarez road, New Delhi 110021, India

CERTIFICATE

This is to certify that **Ms. Akanksha Varun,** M. Tech.IV Semester student ofDepartment of Electronics Science, University of Delhi South Campus has successfully completed his project work entitled "**Design Ku-band Power Amplifier MMIC"** for the partial fulfillment of his Master's degree (M. Tech) in Microwave Electronics from the Department of Electronic Science, University of Delhi South Campus, New Delhi at Solid State Physics Laboratory (SSPL), Delhi from 26th December 2016 to 26th May 2017.

Assistant Prof.P.K. Rao
(Internal Project Guide)
Dept. of Electronic Science
UDSC, New Delhi

Mr. Amit Birwal 1.6.17
(Project Coordinator)
Dept. of Electronic Science
UDSC, New Delhi

Prof. Avinashi Kapoor 1.6.17
Head of Department
Dept. of Electronic Science
UDSC, New Delhi

DEFENCE RESEARCH & DEVELOPMENT ORGANISATION (DRDO)
GOVT. OF INDIA – MINISTRY OF DEFENCE

DEFENCE ELECTRONICS APPLICATIONS LABORATORY
Raipur Road, Dehradun – 248001
Phone: 0135-2787256, Fax: 0135-2787256

Dated: 26th May, 2017

CERTIFICATE

This is to certify that **Mr. Dharmendra Kumar**, a student of **Master of Technology (Microwave Electronics)** from **Department of Electronic Science, University of Delhi South Campus (UDSC)** under class **Roll No. 3664** for the session 2015-2017, has completed the **Dissertation** entitled "**Ku-band Low Noise Amplifier Design**" as an M. Tech. trainee at **Defence Electronics Applications Laboratory (DEAL), DRDO, Dehradun**, during the period 28th Dec 2016 to 26th May 2017. The Dissertation work has been completed under the supervision of **Sh. Rajendra Singh**, Scientist-'F'.

He has done an excellent job and was sincere during his training. He was always enthusiastic to learn, implement and solving problem at hand.

for

Ashok Kumar, Sc-G
Group Director
Millimeter Wave Systems Gp.
DEAL, DRDO

सी.एस.आई.आर राष्ट्रीय भौतिक प्रयोगशाला
CSIR-NATIONAL PHYSICAL LABORATORY
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद)
(Council of scientific & Industrial Research)
डॉ. के.एस.कृष्णन मार्ग, नई दिल्ली 110012,(भारत)
Dr.K.s. Krishnan Marg, New Delhi-110012, (INDIA)

CERTIFICATE

It is certified that the project report entitled "**DESIGN AND CHARACTERIZATION OF SUPERCONDUCTING PATCH ANTENNA**" is submitted by **Subhash Chandra Chaudhary** for the partial fulfillments of the requirement of degree "**Master of Technology in Microwave Electronics Engineering** "is bonafide dissertation work carried out under the supervision of undersigned scientist in Time and Frequency and Electrical and Electronics and Metrology Division at **CSIR-National Physical Laboratory New Delhi** from **26th December 2016 to 26th May 2017**.

This is original project carried out at NPL New Delhi and to the best of our knowledge this work has not been submitted anywhere else for any other Degree or Diploma. We wish his good luck for all his future enduovers.

NATIONAL PHYSICAL LABORATORY
(HRD GROUP)
Endorsement No. 3106-A/14a/16

Ms. Sandhya Malikar Patel
(External guide)
Scientist
National Physical Laboratory
Dr. K. S.
Scientist
Time and frequency and electrical and
Electronic metrology division

डॉ० आर.पी. पन्त / Dr. R.P. PANT
मुख्य वैज्ञानिक एवं प्रमुख एच.आर.डी. ग्रुप
Chief Scientist & Head, HRD Group
सी एस आई आर–राष्ट्रीय भौतिक प्रयोगशाला
CSIR - National Physical Laboratory
डॉ० के. एस. कृष्णन मार्ग, नई दिल्ली–12
Dr. K.S. Krishnan Marg, New Delhi-12

भारत इलेक्ट्रॉनिक्स

BHARAT ELECTRONICS

A GOVT. OF INDIA (MINISTRY OF DEFENCE) ENTERPRISE
BHARAT NAGAR P.O. GHAZIABAD-201010. (U.P.)

HUMAN RESOURCE DEVELOPMENT DEPARTMENT

TRAINING CERTIFICATE

This is to certify that Mr. / Ms. ANIL KUMAR *(UPT/* 1330 */GAD/* 2017 *)*

Pursuing M.TECH *from* DELHI UNIVERSITY SOUTH CAMPUS

has undergone unpaid practical training during the period from 4/01/2017 *to* 26/05/17 *in our organization.*

The project undertaken by him/her was 600 WATT TRASMITTER FOR TRANSPONDER Iff.

His /her performance during the training was EXCELLENT

FOR BHARAT ELECTRONICS LTD.

30/05/2017

प्रभात व्यास
Prabhat Vyas
Manager (HRD/GAD)

DATE: 30/05/2017

MANAGER (HRD)

भारत सरकार - रक्षा मंत्रालय
Govt of India - Ministry of Defence
रक्षा इलैक्ट्रॉनिकी प्रयोज्यता प्रयोगाशाला
Defence Electronics Applications Laboratory
पोस्ट बॉक्स सं0 6, रायपुर रोड
PO Box No. 6, Raipur Road
देहरादून - 248001
Dehradun – 248001

Dated : 29th May 2017

CERTIFICATE

Certified that the report titled **"DESIGN OF X- BAND LOW NOISE AMPLIFIER"** is a bonafide record of the training work carried out by Mr. **Chitransh Srivastava** towards partial fulfilment of the requirements for his Master's Degree (M. Tech.) in Microwave Electronics from the department of Electronics Science University of Delhi South Campus, New Delhi.

The work was carried out from 28th December 2016 to 28th MAY 2017 at Defence Electronics Applications Laboratory (DEAL) and was successfully completed under the guidance of **Shri Dinesh Dwivedi, Scientist-D.**

(Dinesh Dwivedi)
Scientist-D

(Umesh Bahuguna)
Scientist-F
Microwave Systems Group

दूरभाष Tel : 0135-2787083, 84, 256 फैक्स Fax : 0135-2787265, 2787290 ई मेल E-Mail : dealdrdo@del2.vsnl.net.in

इलेक्ट्रानिक्स तथा रेडार विकास स्थापना
भारत सरकार, रक्षा मंत्रालय
रक्षा अनुसंधान तथा विकास संगठन
डी आर डी ओ काम्प्लेक्स, सी वी रामन नगर
बेंगलूर - 560 093, भारत

LRDE
ISO 9001:2008 Establishment

Electronics & Radar Development Establishment
Govt. of India, Ministry of Defence
Defence Research and Development Organisation
DRDO Complex, C V Raman Nagar
Bangalore – 560 093, India

CERTIFICATE

This is to certify that the project work entitled

"DESIGN AND DEVELOPMENT OF WAVEGUIDE ORTHO-MODE TRANSDUCER (OMT) IN KU-BAND FOR SPACE APPLICATION "

is a bonafide work successfully completed by

AMLESH KUMAR SINGH

Student of ***M. TECH. (Microwave Electronics), DEPARTMENT OF ELECTRONIC SCIENCE, UNIVERSITY OF DELHI SOUTH CAMPUS*** *under my supervision and guidance at 'RAMD ' division of* ***ELECTRONICS AND RADAR DEVELOPMENT ESTABLISHMENT (LRDE), Bangalore****, during the period* ***6th Jan 2017 to 26th may 2017****, as a part of the award of Master degree in Microwave Electronics from* ***UNIVERSITY OF DELHI SOUTH CAMPUS , NEW DELHI-110021*** *during the academic year* ***2016-2017.***

RAVI KUMAR SAMMINGA
Scientist ' E'
RAMD, LRDE

सर्व शिक्षा अभियान

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Your Source for R/F And Microwave Components

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Email: sales@mesamicrowave.com

Web: www.mesamicrowave.com

Certificate of Training

Presented to

Mr. Chandresh Pandey

For

Completion of development project "Waveguide Bandpass filter using iris inductive window coupled structure"

Date: 29th May, 2017

We hereby certify that **Mr. Chandresh Pandey,** M. Tech. IV Semester student of Department of Electronics Science, University of Delhi South Campus has successfully completed his project work entitled "Waveguide Bandpass filter using iris inductive window coupled structure" for the partial fulfillment of his Master's degree (M. Tech) in Microwave Electronics from the Department of Electronic Science, University of Delhi South Campus, New Delhi at Mesa Microwave Corporation for environmental monitoring and remote control, Dehradunfrom31st December 2016 to 26th May 2017.

This is to certify that the referenced above Waveguide Bandpass filter is manufactured tested and or inspected in accordance with the requirement of the applicable specifications. Documentary Evidence in the form of test and/ or inspection reports is available upon request.

LORI COFEE

(Authorized Signatory) *Approved by: M.R.* *Rev. Cage Code: 6LBG8*

Lori Coffee

UNIVERSITY OF DELHI SOUTH CAMPUS

The University of Delhi, established in 1922, is a premier University of the country, known for high standards in teaching and research. The University initiated in the early seventies a new concept of a multi-campus system. The South-Campus is the-first new Campus, spread over an area of 69 acres amidst the natural green surroundings on the Aravali hill range. The Campus has developed beautifully with full facilities for students. There is a well equipped library and an Internet Access Network. Hostel accommodation is available on the campus for both, girls and boys.

The South Campus has come to have its own identity by exclusively offering post-graduate courses of applied and professional nature in several subjects and endeavoured to achieve excellence both in teaching and research. The Department of Electronic Science, under the Faculty of Interdisciplinary and Applied Sciences, offers such courses at the M.Sc. level in Electronics as well as the M.Tech. level in Microwave Electronics, and has good research facilities in several areas. The other Departments under the Faculty include Biochemistry, Biophysics, Genetics, Microbiology and Plant Molecular Biology. To keep in pace with the vast changes brought about by the revolution in information technology an Institute of Informatics and Communication has also been established under this Faculty.

The South Campus endeavors have been to develop an ideal environment where the students can grow and become socially conscious, disciplined, responsible and inspiring leaders of the future.

DEPARTMENT OF ELECTRONIC SCIENCE

The Department of Electronic Science was established in 1985 and is widely recognised as one of the most prestigious Electronic Science Departments in the country.

The Department is conducting courses leading to M.Tech in Microwave Electronics and M.Sc. in Electronics. The aim of these programmes is to provide the necessary theoretical background and practical experience in order to meet the requirements of the R&D Organizations and Industries. All students joining the M.Sc. course are required to undergo summer training in the Industry or R&D Organisations. In addition, the M.Tech and M.Sc. students work for 6 months on projects in collaboration with Industry and R&D Organisations. The curriculum of these courses is updated regularly to keep it in consonance with the changing industrial environment. The interface with the Industry is further enhanced by an annual seminar under the Visitor's Programme in which professionals from industry, R&D organizations and academics are invited. Our alumini, now spread over a large number of government and private organisations, facilitate these interactions.

A full range of resources and facilities are available to the students. The department has a well equipped computer laboratory with various circuit simulation and microwave design software for students. In addition, there are well equipped laboratories for experimental work in the following areas: Microwave Measurements, Communication Electronics, Circuit Design, Electrical Machines and Control Systems, Electronic Materials and Semiconductor Devices, Microprocessors and Digital Signal Processing and Optical Electronics.

Attempt is made to assess the students' performance through continuous series of tests and presentations in addition to semester end examinations to ensure highest standards.

The Department is actively helping the students in their placement through Campus interviews. Students graduating from the Department have found positions in both government and private organizations working in Space Applications, Telecommunications and Semiconductors.

The students graduating from the programs have the necessary theoretical and practical skills to take on any R&D and Production responsibilities in today's complex and challenging environment. This is evident from the contributions and achievements of our alumni in organizations like ST Microelectronics, Cadence, HFCL, Aricent, Transwitch, SAMEER, ISRO, DRDO laboratories and many more.

The faculty members are actively engaged in research as well as supervision of research leading to the Ph.D. degree in the field of optical electronics, semiconductors, microwaves and microelectronics. The Department has national and international collaborations and several research projects funded by the UGC, CSIR, DST, MIT, AICTE, DRDO, NSF (USA) and JSPS (Japan).

FACULTY

Dr. Avinashi Kapoor
Professor & Head
Dean, FIAS
Opto-Electronics, Photovoltaics

Dr. P.K. Bhatnagar
Professor
Semiconductor and Nano Materials,
Solid State Devices

Dr. E.K. Sharma
Professor
Fibre/Integrated Optics, Optical Electronics,
Microwave Photonics

Dr. A.K. Verma
Professor
Microwaves, Communication
and Microwave Photonics

Dr. Mridula Gupta
Professor
Communication, Microelectronics
Microwaves

INFRASTRUCTURE FACILITIES

The laboratory training in the department provides students with an exposure to the state of art technologies. This gives them practical skills to meet the growing challenges of industry, R & D and academics.

Computer Facility

The computer facility of the department is equipped with the latest computers and software packages. A formal course in computational techniques provides all students an understanding of numerical techniques and efficient programming practice in high level programming languages. Students are encouraged to use both FORTRAN 77 and C/C++. Use of mathematical tools like Mathcad and Matlab for solving class assignments is also encouraged. Circuit simulation tools like PSpice and Electronic Workbench as well as powerful simulation and design tools for microwave circuits are also available. Internet connectivity is available in the computer lab and other laboratories of the Department.

Semiconductor Materials and Devices

The semiconductor devices and materials laboratory provides experimental setups to study and measure various properties of semiconductor materials. These include Hall measurements, Four -probe method, Vander Pauw Method etc. In addition, characteristics of semiconductor devices like UJT, FET, MOSFET, SCR etc. are also studied.

Integrated Circuit Technology has revolutionized electronics . The laboratory provides an exposure to instruments needed in the initial steps for integrated circuits. This includes creation and measurement of vacuum, deposition of thin films on substrates and pattern transfer techniques like photolithography. A C-V plotter is also available to study the characteristics of devices. More recently sophisticated facilities like x-ray diffraction, UV-VIS-NIR spectrophotometer and Kiethley source-meter have been added with support from the DST (FIST) grant.

Microprocessors and Digital Signal Processing

The laboratory course provides a system level understanding of the 8086 microprocessor involved in the design of microprocessor based electronic equipment. It involves in depth studies of software architecture, instruction set and assembly level programming with PC

interfacing. The students also undertake the programming of the microcontroller 8051 and the interfacing of peripherals.

Digital Signal Processing technology and applications have seen a rapid growth over the last decade. An exposure to this technology is provided through TMSC2054 DSP chips in stand alone mode and with a PC interface. It includes programming for arithmetic operations, waveform generation and the more complex filter designs.

Circuit Design and Simulation

The circuit design laboratory focuses on design of both analog and digital circuits. For a better understanding the design exercises are carried out using discrete active and passive components as well as ICs. Circuit design and simulation software packages like Multisim, PSpice VHDL, active HDL and Electronic Workbench are also used for design and simulation before hardware implementation. Kits for FPGA implementation of digital design are also there. This gives the students a first exposure to design tools used in the semiconductor industry. Advanced simulators like 2D ATLAS, 3D ATLAS, MADICHI and ISE TCAD are also available for use in project work by students.

Communication and Control

Communication laboratory provides a package of experiments that give practical understanding and implementation of Analog and Digital Communication Circuits. It includes basic experiments such as AM, FM, PAM, PWM, PCM, DM, and their application in transreceiver systems.

The experiments on system control include SCR controlled DC motor, DC and AC servo motors, error signal generation, angular variation & analysis, PID control of DC motor with computer interface, Programmable Logic Controller (PLC) and DC Motor Position Control.

Optical Electronics

The laboratory begins with simple experiments designed to understand wave phenomena like diffraction, polarization, Fourier Optics with a laser source on an optical bench. Online pattern measurements by a CCD array connected to a PC have also been introduced. This is followed by characterization of optical sources and detectors, optical fibers and demonstration of optical communication. Fiber splicing machine is also there in the Lab. In addition assignments based on the software package “Understanding Fiber Optics on a PC” provide a comprehensive understanding of the optical fibre. A powerful tool for design of integrated optical devices based on the beam propagation method, BPMCAD from OPTIWAVE is also available for design projects. Units for understanding lasing action in Nd-Yag laser and study of non-linear effects have also been introduced.

Microwave Measurements and Electromagnetics

The Microwave laboratory, with benches for experimental work at the X-band, provides the basic training on microwave measurements. These measurements introduce the basic concepts of waveguides and transmission lines, characterization of Gunn and Klystron sources, cavity resonators, directional couplers etc. Measurements on an antenna turn-table provide basic understanding of the antenna radiation pattern and its parameters. Sophisticated equipment such as Network Analyzer with RF source is also available for measurements on Microwave Integrated Circuits. Advanced Microstrip Trainer Kit is also available in the Lab to impart knowledge about microwave circuits using microstrip technology. Department as milling machine for the PCB fabrication facility and on chip Probe Station.

Microwave Integrated Circuits

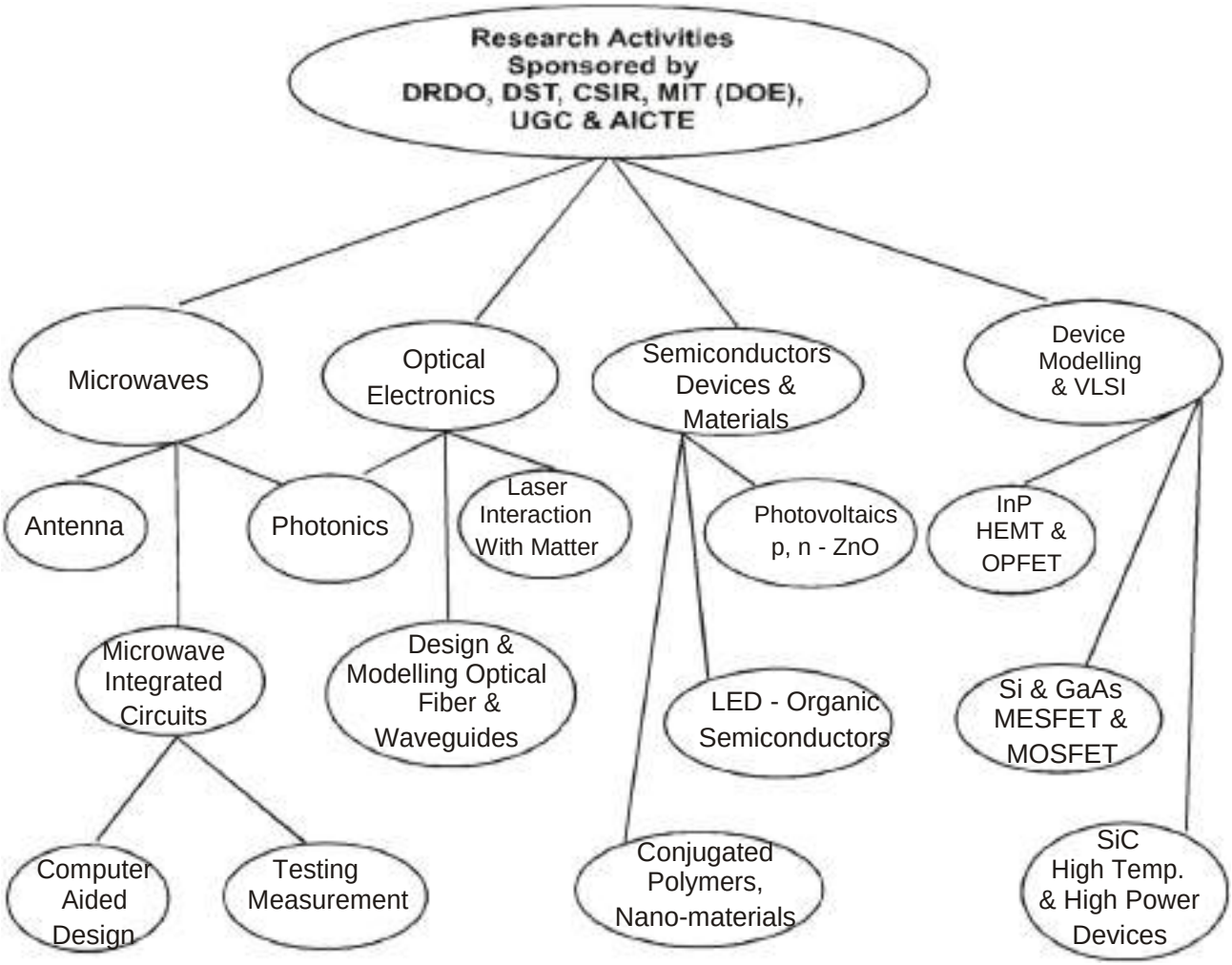
The design and simulation of microwave -integrated circuits forms an important component of the M.Tech. Course. The department has over the time procured some of the best electromagnetic simulators: Ensamble from ANSOFT, IE3D and Empire. Hewlett-- Packard in recognizing the department as a major center of microwave education presented a work-station and one of the best software tools - EESOF’s advanced design software and Momentum. As part of the curriculum students design and simulate various planar microwave circuits like filters, couplers etc., get them fabricated and finally test them with measurements on the Network Analyzer.

DST –FIST Programme

The department has received major grants from DST under FIST (Funds for Improvement of S&T Infrastructure) programme [448] [PSI-075]. In this programme, three instruments namely X-ray diffractometer, UV VIS NIR spectrophotometer and source meter has been procured and commissioned by the department.

RESEARCH PROGRAMS

The faculty of the Department is actively engaged in research in many contemporary areas. The research activity is mainly supported through sponsored projects from various agencies like DRDO, MIT, DST, CSIR, UGC and AICTE. This also provides the basic infrastructure to support the Ph.D. Program of the Department. Students interested in pursuing research work leading to the Ph.D. degree can identify a research area in consultation with any teacher of the department and apply for Ph.D. registration in the Department on a prescribed form at any time of the year. The Board of Research Studies of the Faculty of Interdisciplinary and Applied Sciences approves the registrations recommended by the Department in its meetings held three to four times in a year. The major areas of research are shown in the schematic below:



TEACHING PROGRAMS

The Department offers the following two teaching programs at the University of Delhi South Campus

1. **M.Tech. (Microwave Electronics)**
2. **M.Sc. (Electronics)**

The curriculum and eligibility requirements for these are detailed below.

In addition, the Department also coordinates the undergraduate courses: B.Sc. (Hons.) Electronics and B.A. Sc. (Hons.) Electronics, Instrumentation run in thirteen constituent colleges of the University of Delhi. The M.Sc. program is essentially in continuation from the B.Sc. curriculum.

HOW TO APPLY

The duly filled in application form should be submitted to the Department either personally between 10 a.m. to 1 p.m. and 2 p.m. to 4 p.m. or sent by post. The dates (Ist June to 30 th June) are announced in a nation wide a advertisement by the University of Delhi South Campus. Two copies of the candidates' photo should be affixed at the specified places in the form. The test fee of Rs.500/- and Rs.250/- for SC/ST (for candidates seeking admission through Entrance Test) should be paid through a Demand Draft drawn in favour of the Director, University of Delhi South Campus, payable at State Bank of India, University of Delhi South Campus, New Delhi. Self attested copies of the following certificates should be attached with the application form:

1. High School or Higher Secondary/S.S.C. Examination Certificate (for verification of age).
2. Certificate of qualifying Examination showing marks obtained.
3. Certificate from a competent authority for belonging to SC/ST/OBC/ PH/ CW. (if applicable). *

***The reservation of seats in the above mentioned categories will be as per University rules.**

IMPORTANT:

1. If the form is submitted personally, the eligible candidate will be issued the admission ticket on submission.
2. In the case of form being sent by post, do not detach the admission ticket from the form. Send the full form alongwith a self addressed stamped (Rs.5/-) envelope for sending the admission ticket.
3. Applications without copies of the mark sheets of the qualifying examination/incomplete applications not accompanied by the fee, shall not be accepted.
4. Original certificate will have to be produced at the time of admission.
5. All admissions are provisional subject to approval of the University.
6. All dues must be paid in cash to the cashier on admission within the stipulated period.
7. Incomplete applications are likely to be rejected.

M.Tech. MICROWAVE ELECTRONICS

The M.Tech programme in Microwave Electronics is a four semester, i.e., a two year programme under Faculty of Interdisciplinary & Applied Sciences. This programme was initially sponsored by the Department of Electronics, Government of India in 1976. The aim of the programme is to provide necessary theoretical background and practical experience in the fields of Microwave Devices and Circuits, Microwave Communication, Electromagnetics and Antennas, Microwave Integrated Circuit (MIC), and CAD for Microwaves.

ELIGIBILITY FOR THE M. Tech. COURSE

The eligibility requirements for applying to M.Tech in Microwave Electronics Entrance Test are as follows:

A candidate seeking admission to this course must have passed M.Sc. Electronics or M.Sc. Physics with specialization in Electronics of this University or an equivalent examination of other Universities with at least 60% marks or an equivalent grade.

OR

A candidate seeking admission must have passed B.E. Electrical/Electronics/Electronics and Communication/Instrumentation Engineering from University of Delhi or an equivalent examination of other Universities with at least 60% marks or an equivalent grade.

Candidates appearing for the final year of qualifying examinations can also apply provided they are in a position to obtain their qualifying degree before October of the year of admission.

AGE REQUIREMENT

No student will be qualified for admission to the M.Tech course unless he/she is 21 years of age on or before 1st October of the year of admission. Relaxation of age limit up to a maximum period of six months on the basis of individual merit may be granted by the Vice-Chancellor.

SELECTION PROCEDURE

Candidates for M.Tech. Course will be selected for admission to 30 seats (13 UR, 4 SC, 2 ST, 7 OBC, 04 industry sponsored) on the basis of performance in the entrance test. Out of these, the first 10 students will be eligible for a scholarship of Rs.600/- per month. There are 4 sponsored seats for candidates sponsored by Government R&D Laboratories like DRDO, ISRO, CSIR etc. and Defence.

ENTRANCE TEST

The entrance test (of 3 hour duration) is conducted by the Department in the first week of July at University of Delhi South Campus, Benito Zuarez Road, New Delhi-11 0021.

The test is based on the following topics:

Engineering Mathematics, Networks Analysis, Basics of Computer Programming and Numerical Techniques, Semiconductor Devices, Analog and Digital Communication, Electromagnetics, Transmission Lines and Basics of Microwaves.

ADMISSION LIST

The merit list of the candidates for provisional admission to the M.Tech course is put up on the Notice Board of the Department. Seats are offered to candidates included in the waiting list in order of merit as and when seats are available. Candidates are required to see the Notice Board of the Department for this purpose.

All admissions to the course must be completed on or before 31st July of the year based on the merit list of the Entrance Examination.

ORDINANCE AND SYLLABUS

1. There shall be an M.Tech. Course in Microwave Electronics in the Department of Electronic Science under the Faculty of Interdisciplinary and Applied Science.
2. The duration of the course will be four semesters which is two academic years.
3. A candidate seeking admission to this course must have passed M.Sc. Electronics or M.Sc. Physics with specialization in Electronics of this University or an equivalent examination of other Universities with at least 60% marks or an equivalent grade.

   OR

   A candidate seeking admission must have passed B.E. Electrical/Electronics/Electronics and Communication/Instrumentation Engineering from University of Delhi or an equivalent examination of other Universities with at least 60% marks or an equivalent grade.

   All admissions to the course must be completed on or before 31st July of the year based on the merit list of the Entrance Examination.

   If a student does not attend at least 90% of the classes for two weeks after taking admission, his/ her admission will be automatically cancelled except incase of a medical reason.
4. No person shall be qualified for admission to the M.Tech. Course unless he/she is at least 21 years of age before the First Day of October in the year in which he/she seeks admission. However, the Vice Chancellor may, on the basis of individual merit, relax the age limit up to a maximum period of six months.

Examinations

There shall be following four Semester Examinations in the course:

Semester I Examination: On completion of the course of study for the period prescribed therein in November/December of first year of the course.

A student will be promoted to the second semester provided he/she has not failed in more than two theory papers and has obtained not less than 50% marks in the aggregate of theory and practicals taken together.

The student will have to essentially repeat (ER) and pass in those papers in which he/she has failed. However, the student has to appear in the carried over papers only along with the regular students of the respective semesters in the course of reading which is prescribed for the fresh

students, i.e., odd semester papers in odd semesters (I/III) and even semester papers in even semesters (II/IV).

Semester II Examination: On completion of the course of study for the period prescribed therein in April/May of the first year of the course.

A student will be promoted to the third Semester provided he/she has not failed in more than a total of two theory papers, inclusive of Semester I and Semester II, and has obtained not less than 50% marks in the aggregate of theory and practicals taken together in the Semester II examination. The student cannot carryover more than two papers for essential repeat at any stage.

Semester III Examination: On completion of the course of study for the period prescribed therein in November/December of the second year of the course.

A student will be promoted to the fourth Semester provided he/she has not failed in more than a total of two theory papers, inclusive of Semester I, Semester II and Semester III, and has obtained not less than 50% marks in the aggregate of theory and practicals taken together in the Semester III examination. The student cannot carryover more than two papers for essential repeat at any stage.

Semester IV Examination: At the end of the fourth semester in the month of July. The minimum marks required to pass the fourth Semester shall be 50% in project.

IMPORTANT

A. A student can appear in any theory paper only twice, i.e., once in the original attempt and once in a repeat attempt.

B. The minimum marks required to pass each theory paper shall be 40% in the University Semester Examination (30/75) and 40% in the total of the University Semester Examination and the Internal Assessment taken together.

Attendance: In the case of the I, II and III semester examination, no candidate shall be deemed to have pursued a regular course of study unless one has attended at least three fourths (75%) of the total lectures delivered/classes held in the theory papers and practical papers taken separately. In case of the Semester IV examination, no candidate shaII be allowed to appear at the same unless the supervisor guiding the candidate for the Dissertation work has reported that he/she is satisfied about the project work provided that such reports both from the supervisor and organization shall be to the satisfaction of the Head, Department of Electronic Science.

NOTE

Out of 100 marks in each theory paper, 20 marks will be reserved for sessionals (internal assessment) and 5 marks will be reserved for attendance as per University guidelines.

Each theory paper shall be of three hours duration.

Each practical paper shall be of six hours duration in one day and shall carry 100 marks out of which 40 marks shall be reserved for laboratory record and 5 marks for attendance in the practical classes.

Students will be required to work on the major project in Semester IV. The project can be carried out either completely in the Department or in collaboration with some Industry or an R & D Organization. In the later case, collaboration is to be established by the individual project supervisor.

On completion of the project work, the candidate will submit a dissertation and appear in a viva-voce examination.

Classification of Successful Candidates

At the end of final examination, the successful candidates shall be classified on the basis marks obtained in the I, II, III and IV semester examinations taken together as follows:

First Division with distinction: 75% or more marks in the aggregate.

First Division: 60% or more marks but less than 75% marks in the aggregate.

Second Division: All others.

If a student fails in any paper, he/she will not be eligible for a merit position.

Miscellaneous

a) The calendar for the academic year will be framed and declared at the beginning of the session.

b) Scholarship will be discontinued if the student fails to score at least 60% marks in any examination.

c) The span period for the M.Tech Degree will be four years.

d) A candidate who fails in the I, II or III Semester Examination will be required to repeat that part of the course as a regular student only.

e) There will be no provision of an ex-student.

f) In the case of a student who repeats one or more theory papers, the internal assessment marks will be carried forward.

g) A candidate, who fails in the Semester IV Examination, will be required to repeat the Project. However, he/she may be allowed to complete it in next six months. Such a candidate will be examined in January of that year.

h) There will be no scope of improvement or revaluation.

i) The medium of instruction and examination shall be English.

j) Subject to the statutes and ordinance of the University, M.Tech. Course student shall remain under the control and discipline of the Head, Department of Electronic Science.

I. Scheme of Examination

The following shall be the scheme of examination for the course:

Semester I		
1.1	Electromagnetic Theory and Transmission Lines	100
1.2	Microwave and MM-Wave Planar Transmission Lines	100
1.3	Microwave Measurement Techniques and Industrial Microwaves	100
1.4	Microwave Devices	100
1.5	Microwave Measurements Laboratory	100
	TOTAL	**500**
Semester II		
2.1	Microwave Passive Components	100
2.2	Antenna Theory and Techniques	100
2.3	Communication Theory and Wave Propagation	100
2.4	Computational Electromagnetics	100
2.5	Computational Laboratory	100
	TOTAL	**500**
Semester III		
3.1	Microwave Active Circuits	100
3.2	Communication Systems	100
3.3	Microwave Integrated Circuits (CAD, Fabrication and Measurements)	200
	TOTAL	**400**
Semester IV		
4.1	Major Project (six months duration)	400
	TOTAL (FOUR SEMESTERS)	**1800**

Detailed Syllabus

1.1 Electromagnetic Theory and Transmission Lines

Maxwell's equations, generalized current concept, energy and power, complete power, singularities of the field; Introduction to waves: Plane waves in dielectric and conducting media, reflection and refraction of waves; Basic theory of transmission lines; Computation of RLCG parameters of two wire and classical lines; Smith chart and its applications; Scalar, vector and Hertz potentials and their relations to fields, and gauges; Theorems and concepts: The source concept, duality, uniqueness, image theory, the equivalence principle, fields in half space, reciprocity, construction of solutions; Concept of modes, rectangular wave guide, rectangular cavity, partially filled wave guides, dielectric slab guide, surface guided waves, non-resonant dielectric(NRD) guide; Modal expansion of fields and its applications.

1.2 Microwave and MM-Wave Planar Transmission Lines

Review of development and application of the modern transmission line structures as interconnect and as a medium for realization of components for the MIC and MMIC; Quasi-static and frequency dependent closed form models of microstrip line for effective relative permittivity, characteristic impedance, and dielectric and conductor losses; Effect of conductor thickness, top shield and side-walls on the propagation characteristics of a microstrip line; Closed form models for the coplanar waveguide line for effective relative permittivity, characteristic impedance, and dielectric and conductor losses; Introduction to slot line; Characteristics of coupled microstrip and coupled coplanar waveguide; Circuit models of discontinuities in microstrip lines and the coplanar waveguides: Open ended, short, gap, step, bent, T--Junction. Microstrip line resonator; Microstrip patch resonators-rectangular, circular and ring; Quasistatic space domain and spectral domain analysis of microstrip line, coupled microstrip line and coplanar waveguide.

1.3 Microwave Measurement Techniques and Industrial Microwaves

Microwave Waveguide Components: Attenuators, phase shifters, matched loads, detectors and mounts, slotted-sections, E-plane tee, H-plane tee, hybrid tees, directional douplers, tuners, circulators and isolators; Signal generators: Fixed frequency, sweep frequency and synthesized frequency oscillators;

Noise sources and noise meters used in microwave measurements; Frequency meters and VSWR meters; Measurements of frequency, attenuation, VSWR and impedance; Cavity measurements: Q--factor, bandwidth; Dielectric and magnetic properties of materials: Cavity and Waveguide methods; Measurements of power: Calorimetric and Microwave bridges; Principles of time domain and frequency domain reflectometry, spectrum analyser and network analyser; Measurement of Scattering parameters of passive and active devices.

Microwave in process control instrumentation; Microwave waste disposal; Microwave in agriculture and medicine, hyperthermia etc.; Microwave heating; Microwave absorbers; EMC and EMI.

1.4 Microwave Devices

Microwave Transistor; Microwave Tunnel Diode; Varacter Diode; Schottky Diode; MESFET: Principle of operation, equivalent circuit, cut off frequency, power frequency limitations; MOS Structures; MOSFET: mechanism, modes of operation, transconductance, max operating frequency and microwave applications; HEMT: Structure, operation, characteristics, transconductance and cut off frequency, microwave applications; Charge Coupled Devices (CCD); Transferred Electron Devices: Gunn Diode,

LSA Diode, modes of operation, Microwave Generation and Amplification; Avalanche Effect Devices: Read diode, carrier current and external current; IMPATT diodes.

Klystron: Velocity modulation process, bunching process, output power and beam loading; Reflex Klystron: power output and efficiency; Traveling Wave Tubes; Magnetron.

1.5 Microwave Measurements Laboratory

2.1 Microwave Passive Components and Circuits

The transmission line section as a basic component; Application of Thevenin's theorem to a transmission line; Transfer function of a transmission line section; T and PI representation of a transmission line section; Analysis of two ports and multiports network by using Z, Y and transmission matrix; S-parameter analysis of the microwave circuits; Conversion of Z, Y, transmission parameters and S-parameters; Matching networks: Reactive matching network using the lumped elements; Quarter wavelength transformer, multi section transformer matching section; Lumped planar components like capacitor, inductor and balun; Power divider, Branch line coupler, hybrid ring coupler, directional coupler; Analysis of these components using the S-parameters; Richard transformation and Kurda identities; Inverters, Design of microwave planar filters; Planar Non reciprocal devices: Circulator, delay lines and phase shifters; MEMS technology based microwave components like switches, filters, phase shifters and delay lines.

2.2 Antenna Theory and Techniques

Theory of electromagnetic radiation; Coordinate system and transformation of field quantities in different coordinate system; Basic concept and definition: Directive gain, side lobe, back lobe, polarization, co-polarization and cross polarization level, beam width, input impedance, bandwidth, efficiency; Various kind of antenna with applications; Formulation of radiation integrals and its application to analysis of wire, loop and helix type antenna; Theory of aperture antenna, including the Fourier transform method and application to slot, waveguide and horn antenna; Design consideration of parabolic reflector antenna; Microstrip antenna: Rectangular and circular patch; Feed to microstrip antenna: probe feed, microstrip line feed, aperture feed, electromagnetically fed microstrip patch; Circularly polarized microstrip antenna; Theory of linear array: Two element and multi element array, isotropic and non-isotropic array, Binomial and Chebyshev distribution; Planar array, phased array and adaptive antenna; Feed network of microstrip antenna array; Antenna for mobile communication: handset antenna and base station antenna.

2.3 Communication Theory and Wave Propagation

Probability and random variables; Baye's theorem; Probability density and probability distribution functions, statistical expectation, moments and characteristic functions, various distributions, multiple random variables, transformation of PDFs; Random Processes: Basic concept, description of random process, correlation functions, Stationary and non-stationary process, ergodic process, power and energy;

Multiple random process; Random processes in frequency domain; Fourier transform of random processes, power spectrum of stochastic processes; Gaussian and White processes; Markov process; Various modulation systems and multiple access systems like FDMA, TDMA and CDMA.

Wave Propagation: Free space propagation model, ground reflection; Earth and its effect on propagation, terrain formation considerations and its effects on free transmission, Diffraction and

scattering from obstacles; Atmospheric attenuation; Practical link budget; Troposphere propagation; Tropo system fading characteristics; Troposcatter loss calculations; Fading in LOS troposcatter; Statistical behavior of fading; Diversity techniques.

2.4 Computational Electromagnetics

Review of analytical methods; Green's function; Finite difference methods: Various finite difference schemes, finite differencing of PDEs, accuracy and stability of FD solutions; applications to guided structures such as transmission lines, waveguides; Finite Difference Time Domain Method (FDTD): Yee's FD algorithm, accuracy and stability, lattice truncation conditions, initial fields, programming aspects, absorbing boundary conditions for FDTD; Method of Moments: Introduction, Integral equations, Green's functions, applications to quasi-static problems, radiation problems, mutual impedance between linear elememts, mutual coupling in arrays, rectangular arrays, grating lobe considerations; Applications of FDTD and Method of Moments to wave guide, fin line, planar lines and planar antennas.

2.5 Computational Laboratory Microwave Active Circuits

3.1 Introduction to RF and Microwave active circuits and its application to MMIC; Description of a complete system; Signal flow diagram; Equivalent circuit and models of microwave diode and transistor. S-parameter description of active devices; Classification of RF amplifiers for low noise, medium power and high power application; Biasing, stability and Noise consideration; Matching considerations for maximum power and minimum reflection; Design of microwave amplifier circuits: Narrow band amplifiers; broad band amplifiers, broadband matching; Classification and Design of microwave oscillators: characteristics and performance evaluation; Phase locked loop circuit; Basic mixer concept: Frequency domain characteristics, Single ended mixer design, Single and double balanced mixer. Design consideration and evaluation of a complete receiver and transmitter system.

3.2 Communication Systems

Introduction to Wireless Communication Systems; Global system for mobile(GSM): Cellular concept, System design, Transmission system; Receiving system; Frequency reuse; Channel interference and system capacity; Outdoor and indoor propagation models, small scale and multipath fading; practical link budget; Digital modulation with reference to wireless communication; Spread spectrum modulation; Modulation performances in fading and multipath channel; Multiple access techniques as applied to wireless communication; Pocket Radio system; Wireless networking: 1G, 2G, 3G wireless networks, traffic routing; wireless data service.

Introduction to Satellite Systems; Orbiting satellites, satellite frequency bands, communication satellite systems, satellite modulation and multiple access formats; Satellite systems in India; Satellite receiving systems, G/T ratio; Satellite uplink and downlink analyses in C, Ku and Ka bands; Spot beam, multiple beam, frequency reuse; Satellite transponder; Satellite front end.

Introduction to Optical Communication Systems; Optical fibers, sources and detectors; Analog and Digital systems; Modulation and multiplexing; Power budget analysis; Synchronous optical networks (SONET/SDH); Fiber distributed data interface (FDDI).

3.3 Microwave Integrated Circuits

CAD of Microwave Integrated Circuits, fabrication and measurements.

4.1 Major Project (six months duration).

M.Sc. ELECTRONICS

The M.Sc. Electronics is a four semester programme under faculty of Interdisciplinary & Applied Science initially started in 1984 with the aim to provide necessary theoretical background and practical experience in the field of Electronics.

ELEGIBILITY FOR THE M.Sc. COURSE

Admissions to this course will be in two categories: (I) 50% seats by direct merit on basis of marks obtained in B.Sc. (Hons.) Electronics, University of Delhi (II) 50% seats by entrance examination. Eligibility requirements are given below.

Candidates qualifying for admission under both Categories will be considered in Category I.

	Cat. I	**Cat. II**
General	8	8
Scheduled caste	3	3
Scheduled tribes	1	1
OBC	4	4
Total No. of seats	**16**	**16**

Candidates having passed B.Sc. (Hons.) Electronics from University of Delhi are advised to seek admission through entrance examination in addition to their application under Category I.

Applicants under Category I are required to register at the University of Delhi South Campus as and when announced by the University.

NOTE:

1. In the event of shortfall of admissions under direct quota reserved for B.Sc. (Hons.) Electronics students from University of Delhi, the remaining seats will be added to the quota for candidate seeking admission through entrance test and vice-versa.
2. If the requisite numbers of Scheduled Caste/Scheduled Tribe/OBC candidates are not available by the last date fixed by the University for admission, the remaining seats will be dereserved and will be filled from the general category.

   Relaxation in the minimum eligibility requirements and other provisions are as laid down under University Rules which are detailed in the Admission Bulletin of University of Delhi, South Campus.

Eligibility Requirements for the M.Sc. Course

No.	Course Requirements	Marks Required
	Category I (Admission on Merit Basis)	
1.	B.Sc. (Hons.) Electronics from University of Delhi	
	Category II	
1.	B.Sc. (Hons.) Electronics from University of Delhi	50% or above
2.	B.Sc. (Hons.) Electronics from other Universities	50% or above
3.	B.A. Sc. (Hons.) Electronics, Instrumentation from University of Delhi	50% or above
4.	B.A. Sc. (Hons.) Electronics, Instrumentation from other Universities	50% or above
5.	B.Sc. (Hons.) Physics from University of Delhi	50% or above
6.	B.Sc. (Hons.) Physics from other Universities	50% or above
7.	B.Sc. (Genl.) Physics, Maths, Electronics from University of Delhi	60% or above
8.	B.Sc. (Genl.) Physics, Maths, Electronics from other Universities	60% or above
	All Course Requirements after 10+2+3	

AGE REQUIREMENT

No person shall be qualified for admission to the M.Sc. Course unless he/she is 20 years of age before 1st of the October of the year in which he/she is seeking admission. Provided that the Vice-Chancellor may, on the basis of individual merit, relax the age limit upto maximum period of six months.

ENTRANCE TEST

The entrance test (of 3 hour duration) is conducted by the Department in the first/second week of July at University of Delhi South Campus, Benito Juarez Road, New Delhi-110021 at 10.00 a.m.

Entrance test is based on the syllabus of eligibility courses of the University with emphasis on Electronics.

The examination consists of two sections:

* **Section A:** Objective

* **Section B:** Short Descriptive

The merit list of the candidates based on the entrance test for admission to the M.Sc. course is put up on the Notice Board of the Department on the announced date. Candidates are required to see the Notice Board of the Department for this purpose.

The final admission list under Category II will be released along with the list for Category I. Candidates qualifying for admission under Category I on merit basis as well as through entrance test under Category II will be considered for admission under Category I only and the seats released will be offered to candidates included in the waiting list for Category II in order of merit as and when seats are available.

All admission to course in both categories must be completed on/before 31st July of the year based on merit lists of both categories.

Examinations, Minimum Pass marks, Promotion and Classification of Successful Candidates

There shall be FOUR Semester Examinations comprised in the course. The minimum pass marks shall be 40% in each theory paper and 40% in practicals in each of the three semesters (I, II & III). In IV semester it will be 40% in each theory papers, 40% in Project/Thesis and 40% in Seminar. Minimum pass marks in Summer Training will also be 40%.

Examinations

I Semester Examination: On completion of the study for the period prescribed therein November December of the first year of the course.

At the end of the first semester a student will be promoted to second semester provided he has not failed in more than two theory papers and has obtained not less than 40% marks in the aggregate of theory and practicals taken separately.

The student will have to essentially repeat and pass in those theory papers in which he has failed along with the papers of the second semester. A student who is not promoted to the second semester will have to repeat the first semester as a regular student as and when it runs in the following July-December session.

II Semester Examination: On completion of the course of study for the period prescribed therein April/May of the first year of the course.

At the end of the second semester a student will be promoted to the third semester provided he has passed in all the first semester papers and has not failed in more than two theory papers of the second semester and has obtained not less than 40% marks in the aggregate of theory and practicals taken separately.

The student will have to essentially repeat and pass in those second semester theory papers in which he has failed along with the third semester.

A student who has not passed in all the first semester theory papers at the end of the second semester will be deemed failed in the first semester and will have to join back in the first semester as a regular student in the following month of July and repeat both first and second semesters in sequence.

A student who is not promoted to the third semester, but has passed in all the theory papers of the first semester will be considered pass in the first semester and will have to repeat the second semester as and when it runs in the following January-May session.

III Semester Examination: On completion of the course of study for the period prescribed therein November/December of the second year of the course. At the end of third semester a student will be promoted to the fourth semester provided he has passed in all the second semester papers and has not failed in more than two theory papers of the third semester and has obtained not less than 40% marks in the aggregate of theory papers and has not failed in more than two theory papers of the third semester and has obtained not less than 40% marks in the aggregate of theory and practicals taken separately. The student will have to essentially repeat and pass in those third semester theory papers which he was failed along with the papers of the fourth semester.

A student who has not passed in all the second semester theory papers at the end of the third semester will be deemed failed in the second semester and will have to join back in the second semester as a regular student in the following month of January and repeat both second and third semesters in sequence.

A student who is not promoted to the fourth semester, but has passed in all the theory papers of the second semester will be considered pass in the second semester and will have to repeat the third semester as and when it runs in the following July-December session.

IV Semester Examination: On completion of the course of study for the period prescribed therein in April/May of the second year of the course.

At the end of the fourth semester a student will be declared successful provided he has passed in all the third semester papers and has obtained not less than 40% marks in the aggregate of theory, project/thesis and seminar taken separately.

If at end of the fourth semester a student will be declared successful provided he has passed in all the third semester papers and has obtained not less than 40% marks in the aggregate of theory, project/thesis and seminar taken separately.

If at the end of the fourth semester a student has passed in all the third semester papers and has not failed in more than two theory papers of the fourth semester and has obtained not less than 40% marks in the aggregate of theory, project/thesis and semester taken separately, the student will have to essentially repeat and pass in those fourth semester theory papers in which he has failed during the semester exams held in the following November/December.

A student who has not passed in all the third semester theory papers at the end of the fourth semester will be deemed failed in the third semester and will have to join back in the third semester as a regular student in the following month of July and repeat both third and fourth semesters in sequence.

A student who has not passed the fourth semester, but has passed in all the theory papers of the third semester will be considered pass in the third semester and will have to repeat the fourth semester as and when it runs in the following January-May session.

At the end of the fourth semester the successful candidates shall be classified on the basis of marks obtained as I, II and III division; 60% and above I division, 50% to less than 60% II division, 40% to less than 50% III division.

NOTE: A student who is deemed failed in any semester will join as a regular student over and above the allocated seats for the course. Attendance in two- thirds of the theory classes and three fourths of the practical classes is compulsory, failing which the student will not be allowed to appear in the examination.

Each Semester calendar will ensure a minimum of 40 lectures in each theory course of study.

In each theory paper 20 percent of marks are reserved for Sessional Tests, which will be awarded as the average of two best of three tests conducted by the teacher.

Students will be required to go for Industrial Training for two months in Summer Vacation between IInd and IIIrd Semester.

The total span period for the course will be four years.

A student's admission will be treated as cancelled if he is absent for two weeks continuously from the date of admission.

1. Scheme of Examination

The following shall be the scheme of examination for the course:

Semester I		
1.1	High-level Computer Language and Operating System	50
1.2	Engineering Mathematics	50
1.3	Network Analysis and Synthesis	50
1.4	Advanced Analog and Digital Circuit Design	50
1.5	Practical I : High level Computer Languages and Operating Systems	25
1.6	Practical II : Electronic Circuits	25
1.7	Practical III : Microprocessors	25
1.8	Practical IV : Computational Techniques	25
	Semester I total	**300**
Semester II		
2.1	Electromagnetics, Antenna and Propagation	50
2.2	Seminconductor Devices and Materials	50
2.3	Microprocessors	50
2.4	Signal Systems and Control	50
2.5	Practical I : Electromagnetics	25
2.6	Practical II : Materials and Semiconductor Devices	25
2.7	Practical III : Circuit Design and Simulation	25
2.8	Practical IV : Electrical Machines and Control Systems	25
	Semester II total	**300**
	Summer Training (8 weeks)	**50**
Semester III		
3.1	Optical Electronics	50
3.2	Integrated Circuit Technology	50
3.3	Digital Signal Processing	50
3.4	Communication Systems	50
3.5	Practical I : Optical Electronics	25
3.6	Practical II : Science and Technology of Semiconductor Devices	25
3.7	Practical III : Digital Signal Processing	25
3.8	Practical IV : Communication Systems	25
	Semester III total	**300**
Semester IV		
4.1	Quantum Electronics	50
4.2	VLSI Circuit Design and Device Modeling	50
4.3	Modern Communication Systems	50
4.4	Microwave Electronics	50
4.5	Seminar	25
4.6	Lectures from Industry	25
4.7	Project	200
	Semester IV total	**450**
	Grand Total	**1400**

Detailed Syllabus

1.1 High-level Computer Languages and Operating Systems

Operating Systems: familiarity with various operating systems like DOS, OSII, GUI like Windows, UNIX & LINUX. Details of one operating system such as UNIX: introduction, multitasking, multiuser capabilities, UNIX basis, files and directories, understanding the UNIX shell, text processing in the UNIX environment, editors like VI, EMAC, SED. Programming languages (one high level language such as C++) : introduction to C++ and object oriented programming, development environment, compiling and linking the source code, brief look at crout, comments,' variable and constants, expressions and statements, functions, classes, pointers, references, overloading, arrays, inheritance, special classes and functions, streams and files, the preprocessor, object-oriented analysis and design, templates, exceptions & error handling, standard libraries and bit manipulation.

1.2 Engineering Mathematics

Sturm-Liouville's problem: applications and examples. Calculus of variations with examples. Partial differential equations: Laplace, wave and diffusion equations in various coordinate systems. Integral equations and methods of solutions. Green's function technique and its application. Approximate techniques of engineering mathematics: perturbation method, variational methods, method of weighted residues, WKB method. Contour integration, conformal mapping. Transforms: Laplace, Fourier & FFT.

1.3 Network Analysis and Synthesis

Time domain analysis of networks (differential equation approach). Thevenin and Norton's theorems, reciprocity theorem, Tellagan's and Millman's Theorems. System function approach to network analysis, graph theory, mesh and node analysis, poles and Zeros. Laplace Transform, Hurwitz Polynomials, positive real functions. Synthesis of reactive ports by Foster's and Cauer's Methods. Synthesis of R-L, R-C, and R-L-C-networks.

1.4 Advanced Analog and Digital Circuit Design

Practical Analog and Digital Circuit Design of amplifiers (single and multistage, audio and RF range) and power amplifiers. Design process as a troubleshooting tool. Oscillators, Mixers and PLL. Review of Logic families tabular and computer aides minimisation procedures. Programmable Logic Array. Clock mode sequential machines, incompletely specified sequential machines and fundamental mode sequential machines.

1.5 Practical I : Hiqh level Computer Languages and Operating Systems-

1.6 Practical II : Electronic Circuits

1.7 Practical III : Microprocessors

1.8 Practical IV : Computational Techniques

2.1 Electromagnetics, Antenna and Propagation

Transmission lines: transmission line equation in time and frequency domain, losses and dispersion, reflection from an unknown load; quarter wavelength, single stub and double stub matching; Smith Chart and its applications. Maxwell's equations, constitutive relations, wave equation, plane wave functions, rectangular waveguide, circular waveguide, dielectric slab waveguide surface guided

waves. Antenna parameters, radiation from simple dipole and aperture, concept of antenna arrays, end fire and broadside arrays, horn antenna, microstrip antenna, parabolic disc antenna. Ground wave, space wave and ionospheric propagation. Communication link budget for ground transmission.

2.2 Semiconductor Devices and Materials

Crystalline, polycrystalline and amorphous semiconductors: energy bands, carrier transport, excess carriers. injection and recombination of the excess carriers, the mechanisms involved. Basic equations for semiconductor device operations: continuity equation, current flow equation, carrier transport equation and their solutions. Binary, ternary and quaternary compounds and their applications. Characterisation of semiconducting materials. p-n Junction diodes: abrupt and linear, electrical breakdown, tunnel diode, Schottky barrier diode, majority carrier diodes. Microwave diodes: Varactor diode, p-i-n diode, transferred electron devices. Optoelectronic devices: solar cell, photodetector, LED, semiconductor laser. JFET, MESFET, MOS capacitor, MIS diode, MOSFET. Basic idea of charge coupled Devices. Quantum well structures and low dimension physics.

2.3 Microprocessors

Microprocessor based design, design constraints, microprocessor selection, hardware implementation, software implementation, hardware debugging, software debugging. Introduction to 8086, 8088, 80186, 80188, 6800, 68000 and other latest chips of Intel/Motorala microprocessors. 8086 Internal architecture, introduction to programmable parallel ports and hand-shake, input-output, interfacing the microprocessor to keyboards, alphanumeric displays and high power devices. The 8086 Maximum code, DMA data transfer interfacing and refreshing dynamic RAM, processors with integrated peripherals, the 80186, the 8087 math coprocessor. Multiple bus microcomputer system.

2.4 Signal Systems and Control

Introduction with examples of. various kinds of continuous and discrete time signals and their mathematical representation. Signal energy and power. Even and odd signals. Periodic, exponential and sinusoidal signals. Unit impulse and unit step functions for both discrete and continuous time signals. Examples and mathematical representation of continuous and discrete time systems. Difference equation. Basic vector matrix form of state equation. Basic system properties. Discrete time Linear Time Invariant (LTI) systems with cQnvolution sum. Continuous time LTI system with convolution integral. Fourier series and transform application to analysis of signals and systems.

Introduction to control with examples of feedback control systems from several fields. Block diagram, transfer function and signal flow graph. Mathematical modelling of physical systems. Time domain and frequency domain analysis of control systems. Stability criteria, rootlocus techniques.

2.5 Practical I : Electromagnetics

2.6 Practical II : Electronic Materials and Semiconductor Devices

2.7 Practical III : Circuit Design and Simulation

2.8 Practical IV : Electrical Machines and Control Systems

3.1 Optical Electronics

Review of basic optics: wave propagation, polarisation, diffraction, Gaussian beams. Electrooptic effect, electro-optic modulators and their design considerations. Acousto-optic effect, Raman Nath and Bragg diffraction, acousto-optic modulators and deflectors. Principles of optical communication systems, optical sources and detectors. Optical fibers: modes of an optical fiber, multimode fibers, single mode fibers and their propagation characteristics. Dispersion management in optical fibers and link design considerations. Integrated optics: planar and channel waveguides, directional couplers, optical switch, electro-optic and acousto-optic waveguide devices. Display devices, holography and optical information processing.

3.2 Integrated Circuit Technology

Material purification. Epitaxial growth: LPE, VPE, MBE. Clean room specifications and requirements. Vacuum technology, sputtering, oxidation, growth mechanism and kinetics (thin and ultrathin oxides), oxidation techniques, redistribution of dopants at the interface and oxidation induced defects.

Diffusion: Fick's law, diffusion mechanism, measurement techniques, diffusion in SiO_2. Ion Implantation : systems and dose control, ion range, ion stopping, knock on ranges, metalization choices. Etching: dry etching, pattern transfer, plasma etching, sputter etching, control of etch rate and selectivity, control of edge profile. Process simulation and process integration. Lithography: optical, electron beam, ion beam, X-ray lithography, lift off, dip pen. Pattern generation. Fabrication of few devices like MMIC, laser diode etc.

3.3 Digital Signal Processing

Discrete time signal analysis and linear systems. Sampling of continuous time signals. Z-transform, properties of region of convergence of Z-transform, inverse Z-transform, unilateral Z-transform. Structures of discrete time systems, block diagram and signal flow graph representation of linear constant coefficient difference equation. Basic structures for ILR and FIR filters, lattice structures, effect of coefficient quantisation, effects of round-off noise in digital filters. Filter design techniques, Discrete Fourier Transform and Fast Fourier Transforms. Concept of multirate digital signal processing.

3.4 Communication Systems

Frequency allocation and standards. Analog Transmission: AM, FM and PM (modulation, demodulation techniques and noise Analysis), AM and FM transmitters and receivers. Digital transmission: sampling and digital multiplexing techniques, PAM, PWM, PPM, PCM, DM, line codes, Information theory, ASK, FSK, PSK and QAM.

3.5 Practical I : Optical Electronics

3.6 Practical II : Science and Technology of Semiconductor Devices

3.7 Practical III : Digital Signal Processing

3.8 Practical IV : Communication Systems

4.1 Quantum Electronics

Interaction of radiation with matter: light amplification and laser operation. Optical resonators. Properties of laser radiation, mode selection, Q-switching and mode locking. Various types of

lasers and applications: gas lasers, solid-ion lasers etc. Semiconductors lasers. Optical amplifiers: doped fiber amplifiers, design considerations, amplified spontaneous emission (ASE) and noise figure. Nonlinear optics: second and third order nonlinerity, second harmonic generation; sum and difference frequency generation, parametric amplification, stimulated Raman and Brillouin scattering, self phase modulation, temporal and spatial solitons.

4.2 VLSI Circuit Design and Device Modeling

Passive elements design, design of silicon integrated circuits. Basic MOS inverter design, transfer characteristics, logic threshold, NAND & NOR logic, transit time and inverter time delay, depletion and enhancement modes, CMOS inverter, inverting and non-inverting type super buffers. Optimization of NMOS and CMOS inverters, noise margins MOS design rules. MOS layers, Stick diagrams, NMOS design layout diagrams, CMOS design, design rules and layout. Lamda bases design rules. Scaling of MOS Circuits. Functional Limitations to scaHng, scaling of wires and interconnections. MOS memories and programmable logic arrays, non-volatile semiconductor memeories with MOS technology. General considerations associated with VLSI design. Design of a four-bit shifter, design of an ALU sybsystem. Physical model for Si VLSf, MOSFET modeling, short channel structures, scaled down MOS performance. Packaging of VLSI devices, packaging types. Packaging design consideration, VLSI assembly technology and fabrication technologies. Mechanism of yield loss in VLSI, modeling of yield loss mechanism, reliability requirements for VLSI. Failure mechanism in VLSI. Fault finding in VLSI chips.

4.3 Modern Communication Systems

Data transfer and computer networking: packet switching, ISDN, ATM, LAN, WAN, Internet and WAP. Digital Radio Communication Systems; Transmission media, sampling, multiplexing, digital modulation and multiple access techniques.

Satellite Communication Systems: principles of satellite communication, modulation, multiplexing and; multiple access techniques; satellite services like DBS, VSAT etc. Mobile communication: specifications, design approach and details. Optical Communication Systems: network topologies, Fiber Distributed Data Interface (FDDI) network, Synchronous Optical Network (SONET/SDH), Asynchronous Transfer Mode (ATM), Wavelength Division Multiplexing (WDM) and its network implementation.

4.4 Microwave Electronics

Introduction to microwaves and their publications; Klystron amplifiers: operation and analysis, power and efficiency, multi cavity klystron. Reflex klystrons: operation and analysis, electronic admittance, electronic tuning, power output and deficiency. Magnetrons: operation and analysis. Travelling Wave Tubes: operation, gain bandwidth, coupling and focusing methods, applications. Avalanche Diode, Gunn effect and Gunn diode oscillators. Solid state microwave amplifiers, oscillators and mixers. Microwave components: attenuator, phase shifter, slotted lines, frequency meter, directional couplers, E-plane Tee, Magic Tee and Ferrite devices basic measurements of frequency, SWR, impedance and power at microwave frequencies. Principles of microwave LOS communication. Introduction to RADAR.

4.5 Seminar

4.6 Lectures from Industry

4.7 Project

TRAINING AND PLACEMENTS

The Department arranges placement facilities for summer training and project work in leading organizations in the private and public sector. These programs give students an exposure to state of art facilities which are not available in the University environment.

For both M.Sc. and M.Tech students, Campus interviews are arranged at the Department for the purpose of placement.

Following are some of the organisations where students have found placement through Campus selections:

ISRO	LRDE	CADENCE
SAC	GAETEC	HP/AGILENT
SSPL	DLRL	VXL
NPL	EMINENT TECHNOLOGY	TRANSSWITCH
LASTEC	MOTOROLA	SIEMENS
DEAL	TCS	ATRENTA
SAMEER	ASTRA MICROWAVES	NOKIA
CEERI	ARICENT	SHYAM TELECOM
C-DOT	ST MICROLECTRONICS	HSL ASIA
SAPIENT	HSS	RF ARRAY

Placement Coordinator

Dr. Mridula Gupta
Professor
Department of Electronic Science
University of Delhi South Campus
New Delhi-110021, India
E.Mail: mridula_du@yahoo.com
Tel: 011-24115580

BEYOND TEXT BOOKS

Library

Class Seminars

Alumni Meet

Conferences

Educational Trip

Industry Interaction

FEE PAYABLE FOR THE COURSES

The student selected to the M.Tech and M.Sc. Courses will have to pay the fee for Ist year at the time of admission and complete the admission procedure within the time allowed

Fees in Rs.		**M.Tech**		**M.Sc.**	
		Ist Year	**2nd Year**	**Ist Year**	**2nd Year**
Tution Fee (For 12 months)		**240/-**	**240/-**	**216/-**	**216/-**
Admission fee (Re-enrolment)		15/-		15/-	
University Enrolment fee	Other Universities	150/-		150/-	
	Delhi University	100/-		100/-	
Student Union Fee (SDC)		25/-	25/-	25/-	25/-
Magazine Fee		20/-	20/-	20/-	20/-
Sports fee		50/-	50/-	50/-	50/-
Student Welfare		20/-	20/-	20/-	20/-
Association fee		10/-	10/-	10/-	10/-
Culture Council		5/-	5/-	5/-	5/-
University Union fee		5/-	5/-	5/-	5/-
Athletic Association Fee		5/-	5/-	5/-	5/-
University Development fee		300/-	300/-	300/-	300/-
WUS Contribution		120/-	120/-		
Identity Card		10/-		10/-	
University Library fee		15-/-	15/-	15/-	15/-
Library Development fee		200/-	200/-	200/-	200/-
Library Deposit (Refundable)		1000/-		1000/-	
Lab. Development fee (Non-refundable)	Regular Student	2000/-	2000/-	2000/-	2000/-
	Sponsored Candidates	20,000/-			
Lab. Caution fee		25/-		25/-	
Lab. Fee		20/-	20/-	20/-	20/-
NSS Fee		20/-	20/-	20/-	20/-
SH Fund		10/-	10/-	10/-	10/-
Total					
Delhi University		**4215/-**	**3065/-**	**4071**	**2921/-**
Other universities		**4265/-**	**3065/-**	**4121/-**	**2921/-**
Sponsored candidates (Delhi Univ.)		**22215/-**	**1065/-**	**-**	**-**
Sponsored candidates (Other Univ.)		**22265/-**	**1065/-**	**-**	**-**

Disclaimer:
Although care has been taken to give correct information, bit the Department does not have any responsibility if something is left out and missing or changed inadvertently.

अन्तर-विश्वविद्यालय त्वरक केन्द्र
INTER-UNIVERSITY ACCELERATOR CENTRE
(Formerly Nuclear Science Centre)
(विश्वविद्यालय अनुदान आयोग का स्वायत्त केन्द्र)
(An Autonomous Centre of UGC)

Dated: 31/07/2017

Summer Training Certificate

This is to certify that, **Mr. Lokesh Joshi**, student of M.Sc. (Electronics), **University of Delhi** has successfully completed his 2 months **(from May 22, 2017 to July 22, 2017)** summer internship

The project was undertaken by him in BTS Lab, IUAC where he worked on **"*Development and testing of Web based Data Logger for MHB control electronics*"** as an application of IoT for Accelerators.

His conduct during the training period was good. We wish him success in future.

Ashish Sharma

Mr. Ashish Sharma
Engineer

Dr. P. Sugathan
Programme Coordinator

डा. पि. सुगथन / Dr. P. Sugathan
Scientist 'F'
Research Coordinator
अन्तर-विश्वविद्यालय त्वरक केंद्र
Inter-University Accelerator Centre
Aruna Asaf Ali Marg, New Delhi-110 067
[illegible]an@iuac.res.in

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Electropreneur PARK

Funded and Supported by MeitY, Government of India

University of Delhi, South Campus
III Floor, Library Building, Benito Juarez Road
New Delhi - 110 021
Tel. : +91 11 65164488
www.electropreneurpark.com

25th July, 2017

TO WHOMSOEVER IT MAY CONCERN

This is to certify that **Mr.Rahul Soni**, a student of Department of Electronic Science, University of Delhi, South Campus has successfully completed 2 (two) months training at EVI Technologies Private Limited a company incubated at Electropreneur Park.

The period for his training as per our records was from May 22, 2017 to July 20, 2017.

During the period of his training programme with us he was found punctual, hard-working and inquisitive.

He assisted the technical team of EVI Technologies Private Limited in their project VCube EV charger system designed with major contribution under power sensing and feedback circuitry. Further, he developed a standalone android application for VCube operation which was successfully tested.

During his training he was not paid any stipend nor any stipend is due to be paid to him by Electropreneur Park.

We wish him all the success in his future pursuits.

For Electropreneur Park

Authorized Signatory

Electropreneur Park ★ University of Delhi South Campus ★ EP

Defence Institute of Physiology and Allied Sciences
रक्षा शरीरक्रिया एवं संबद्ध विज्ञान संस्थान
(An ISO 9001 : 2000 Certified Institute)

Govt. of India, Ministry of Defence, Defence Research & Development Organization
भारत सरकार रक्षा मंत्रालय रक्षा अनुसंधान एवं विकास संगठन
Lucknow Road, Timarpur, Delhi – 110 054
लखनऊ रोड, तिमारपुर दिल्ली - 110 054

Certificate

This is to certify that **Mr. PRABHAT PRAJAPATI** student of **M.Sc. ELECTRONICS , UNIVERSITY OF DELHI, SOUTH CAMPUS, DELHI-110021** have undergone summer training from 22th May 2017 to 20th July 2017 in Biomedical Instrumentation Division on **"SIMULATION AND PCB IMPLEMENTATION OF LOW LEVEL LIGHT THERAPY DEVICES".**

(Dr. Shweta Rawat)
Sc 'D'
HRD Coordinator

Director : 91-11-23914774 Office : 91-11-23883111
FAX No : 91-11-23932869 E-mail : hrddipas@yahoo.com

भारत इलेक्ट्रॉनिक्स

BHARAT ELECTRONICS

A GOVT. OF INDIA (MINISTRY OF DEFENCE) ENTERPRISE

BHARAT NAGAR P.O. GHAZIABAD-201010. (U.P.)

HUMAN RESOURCE DEVELOPMENT DEPARTMENT

TRAINING CERTIFICATE

This is to certify that Mr. / Ms. Km. AKSHA *(HRD/ UPT/374/MSC)*

Pursuing MSC (Electronics) *from* University of Delhi South Campus (UDSC)

has undergone unpaid practical training during the period from 22nd - May - 2017 *to* 20th - July - 2017 *in our organization.*

The project undertaken by him/her was "Rohini Radar"

His /her performance during the training was Excellent

For BHARAT ELECTRONICS LTD.

Date: 20th - July - 2017

MANAGER (HRD)
प्रभात व्यास
Prabhat Vyas
प्रबन्धक (मा.स.वि./ गा.बाद)
Manager (HRD/GAD)

Grams : 'COMBAIR'
Fax : +91-80-25216861

Tel Dir +91-80-25296953
Tel Gen: +91-80-25202973 - 77
Extn 7801

ADA

AERONAUTICAL DEVELOPMENT AGENCY

Campus II
Technology Directorate of Avionics & Weapon Systems
(Ministry of Defence, Govt. of India)
Suranjandas Road, New Thippasandra Post, Bangalore - 75, India

Date: 20/07/2017

To,
Whomsoever concerned

I hereby certify that Pallavi T. has completed her summer training at our organization Aeronautical Development Agency (ADA) for a period of 2 months from 24-05-2017 to 20-07-2017. During this period, she has completed a project titled 'Analysis of LCA Flight Data using MATLAB' under my guidance.

20/7/17

Nirmala Satishkumar
Sc/Engr 'F'
Aeronautical Development Agency (ADA)

ISO 9001:2008 Certified

ठोसावस्था भौतिकी प्रयोगशाला, दिल्ली
Solid State Physics Laboratory, Delhi

File No.1805/ 87 /HR/SSPL/ 17
Dated 26/07/2017

(Min. of Defence, DRDO)
Lucknow Road, Timar Pur, Delhi-110054

प्रशिक्षण प्रमाणपत्र / TRAINING CERTIFICATE

This is to certify that ~~Mr.~~/Ms./ ASMITA DEEP

Student of DEPT. OF ELECTRONIC SCIENCE, SOUTH CAMPUS (D.U.) Roll No. 3704

Branch M.Sc ELECTRONICS has completed successfully Summer/~~Winter~~ Internship

for the period from 22/05/2017 to 24/07/2017 Duration TWO (2) ~~weeks~~ / months.

Topic of Internship was DESIGN OF A GaN-HEMT BASED POWER AMPLIFIER USING HYBRID MIC TECHNOLOGY

During the training period ~~his~~/her conduct at SSPL was good.

(Dr. Chandra Prakash)
Group Director (Admin, HR & Tech Coord)

UVSOFTS TECHNOLOGIES

REG. ID - UVS/STP/17/0023

Certificate of Training

This is to certify that Mr. / Ms. SOMISHANG JAGOI

of DOES SOUTH CAMPUS, UNIVERSITY OF DELHI

has undergone Summer Training Program'17

in EMBEDDED SYSTEM

from 22/05/2017 to 20/07/2017

For UVSOFTS TECHNOLOGIES PRIVATE LIMITED

Director

Mr.Vishal Singh
Training Coordinator

Er. U. S. Yadav
Director

UVSofts Technologies Pvt. Ltd.

सेन्ट्रल इलेक्ट्रॉनिक्स लिमिटेड
Central Electronics Limited
भारत सरकार का उद्यम
(A GOVERNMENT OF INDIA ENTERPRISE)
4, औद्योगिक क्षेत्र, साहिबाबाद - 201010 (यू0पी0)
4, Industrial Area, Sahibabad - 201010 (U.P.)

Web Site : www.celindia.co.in
E-mail : cel@celsolar.com
Fax : 0120-2895148

Phone Nos. :
0120-2895143

ISO-9001-2008
ISO-14001-2004
Certified

No.C-5 (b)/II-76/18

Dated: 20/07/2017

To Whomsoever It May Concern

This is to certify that Ms. Sandhya D/o Shri Padam Singh a student of M.Sc. (Electronics Science), Department of Electronics Science, UDSC, New Delhi, Roll/Enrl. No. KC-1127/2013 has undergone summer/ industrial training (unpaid) from (22/05/2017) to (20/07/2017) in the Company, as per this office letter of even no. dated 22/05/2017.

Asstt. General Manager (HRD)

अन्तर-विश्वविद्यालय त्वरक केन्द्र
INTER-UNIVERSITY ACCELERATOR CENTRE
(Formerly Nuclear Science Centre)
(विश्वविद्यालय अनुदान आयोग का स्वायत्त केन्द्र)
(An Autonomous Centre of UGC)

Dated: 31/07/2017

Summer Training Certificate

This is to certify that, **Mr. Enokh Wajri**, student of M.Sc. (Electronics), **University of Delhi** has successfully completed his 2 months **(from May 22, 2017 to July 22, 2017)** summer internship.

The project was undertaken by him in BTS Lab, IUAC where he worked on ***"Development of interfacing board for Web based Data Logger for MHB control electronics"*** as an application of IoT for Accelerators.

His conduct during the training period was good. We wish him success in future.

Ashish Sharma

Mr. Ashish Sharma
Engineer

Dr. P. Sugathan
Programme Coordinator

डा. पि. सुगतन / Dr. P. Sugathan
Scientist 'H'
Research Coordinator
अन्तर-विश्वविद्यालय त्वरक केंद्र
Inter-University Accelerator Centre
Aruna Asaf Ali Marg, New Delhi-110 067
email : sugathan@iuac.res.in