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*Title* : *Timing Synchronization of Bandwidth Efficient Coded OFDM Systems*

*Author(s)* : *Samal Umesh Chandra*
*Roll No* : *Y9104099*
*Supervisor(s)* : *Vasudevan KS*

*Abstract*

In this work, we propose data aided (DA) timing synchronization schemes for orthogonal frequency division multiplexed (OFDM) signals, transmitted through independent Rayleigh fading multipath channels, in the presence of additive white Gaussian noise (AWGN) and frequency offset. The channel is assumed to have an exponential power delay profile. The timing metric is independent of the preamble structure. The OFDM subcarriers are modulated by QPSK signals. The proposed timing synchronization algorithm estimates the starting point of OFDM frames by using a filter that is matched to a known preamble. The performance of the proposed scheme is simulated and compared in terms of probability of erasure (PE) probability of not detecting a frame when it is present) and mean squared error (MSE), with the previously existing timing synchronization methods for OFDM systems. The simulation results indicate that the proposed method improves the performance of the system significantly. Moreover, the computational complexity for the proposed timing synchronization method is less as compared to previously existing methods, which is helpful in real-time applications. In order to improve the throughput, the same preamble can be used for frequency offset and channel estimation. Next, bandwidth efficient turbo codes, commonly known as turbo trellis coded modulation (TTCM) is proposed for OFDM systems. It improves the bit-error-rate (BER) performance and spectral efficiency simultaneously, which are the major requirements for modern communication systems. The throughput can be improved by puncturing. In addition to TTCM, data interleaver (DI) is incorporated to enhance the BER performance of the system further. The BCJR algorithm is used at the receiver to decode iteratively the received turbo trellis coded interleaved OFDM signals. Simulation results study the performance of TTCM schemes with and without DI for different values of preamble and data lengths, assuming non-ideal synchronization, channel and frequency offset estimation.

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***Title*** : ***Performance Optimization of npn SiGe HBT On Thin Film SOI***

***Author(s)*** : ***Misra Prasanna Kumar***
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***Abstract***

The lithography for the advanced SOI CMOS technology node is expensive (e.g. 45 nm and 32 nm technology). The same performance can be achieved by the hetero-junction bipolar transistor at higher lithography node. If the hetero-junction bipolar transistor is integrated with SOI CMOS technology, the benefits from both devices can be exploited while designing mixed signal circuits. Therefore, the BiCMOS technology can be used at higher lithography node without compromising the performance. Further, the BiCMOS technology at higher lithography node (130/90 nm) is cheaper compared to the advanced SOI CMOS technology (e.g. 45/32 nm). In this thesis, the npn SiGe HBT compatible with 130 nm partially depleted SOI CMOS technology has been studied. The process and device simulations have been performed for the SOI HBT. The collector length is scaled to study the trade off in the performance of the HBT. The results are compared with the HBT for highly doped all implanted collector. The potential of the SOI HBT is explored for low power applications. The collector of the HBT is engineered by a buried layer followed by a deposited epitaxial layer. The collector thickness is kept same as in 130 nm PDSOI MOSFETs. This approach is investigated to add the HBT module to 130 nm PDSOI CMOS technology. The device performance is compared to the all implanted collector based HBT. The HBT is investigated by incorporating the buried silicide layer. The epi layer doping and the thickness is optimized and the ftBVCEO product of the HBT is studied. Further, the performance scaling of the transistor has also been investigated. The SOI HBT is laterally and vertically scaled from 130 nm to 65 nm lithography node. The limitations and the challenges in scaling the SOI HBT are discussed. The DC and AC characteristics of the SOI HBT are obtained by applying scaling and the results are compared. The SOI HBT at 65 nm lithography node would be useful for sub terahertz applications. Further, programmability of SOI HBT using body bias has also been studied

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*Title* : *Early Detection & Control of Voltage Stability and Fast Assessment of ATC using Synchrophasor Measurements*

*Author(s)* : *Chintapalli V V S Bhaskara Reddy*

*Roll No* : *10104112*

*Supervisor(s)* : *Srivastava S C&Chakrabarti Saikat*

*Abstract*

With the changes in the electricity utility structure, increased interconnections and loading, stable and secure operation of the present day power systems, has become a challenging task. Among the various types of instabilities, the voltage instability has been observed in several utility networks leading to system collapse and major blackouts. Recent development of the Wide Area Monitoring System (WAMS), based on synchrophasor technology, has potential for the real-time monitoring and control of the power system. In the restructured market environment, Available Transfer Capability (ATC) of the transmission system needs to be computed and posted for market participants to decide the level of additional secure transactions in the market. This work has developed new methods for advance prediction of voltage stability, its enhancement using various controls and fast assessment of ATC, suitable for synchrophasor based measurements. A new algorithm for Improved System Voltage Instability Monitoring Index (ISVIMI) using synchrophasor measurements is proposed, for early detection of the voltage instability. This utilizes the weighted sum of the deviation of the bus voltage magnitude from its reference value and rate of voltage decay/rise using synchrophasor measurements. A procedure for auto tuning of proportional weights, for the index calculation is also considered. An algorithm to enhance the voltage stability of the system using L-index sensitivity is developed, which is one of the commonly used indices for voltage stability assessment. Procedures for calculation of L-index sensitivity and optimal settings of the controlling devices, for improving the power system voltage stability are also been suggested. Further, an algorithm to improve the system voltage stability, using reduced system model and synchrophasor measurements, is also developed. This includes a procedure for selecting the critical buses, obtaining reduced system model, updating the reduced system parameters using sequential regression, and obtaining optimal settings of the controlling devices for enhancing the system voltage stability. A method for fast assessment of ATC using synchrophasor measurements is also suggested. It utilizes the existing power transfer distribution factors and angular measurements from the Phasor Measurement Units (PMUs) across the critical corridor for ATC assessment. A procedure for obtaining the critical corridors and critical contingencies is also developed. Test results have been obtained on 9-bus WECC, 39 New England bus and 246 bus Indian systems. Testing of the algorithms, developed for early detection of voltage stability monitoring and fast assessment of ATC, has also been carried-out in real time environment on Real Time Digital Simulator (RTDS®). Algorithm developed for enhancement of the system voltage stability using L-index sensitivity is tested on OPAL-RT simulator.

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*Title* : *Wind Power Forecasting and its Applications in Optimal Bidding and Optimal Reactive Power Dispatch of Wind Farms*

*Author(s)* : *Kanna Bhaskar*
*Roll No* : *10104114*
*Supervisor(s)* : *Singh Sri Niwas*

*Abstract*

Wind power generation has been the fastest growing renewable energy generation system since last few decades. This is mainly due to the growing concerns about global warming and depleting fossil fuels. Also, with the development in power electronic design and converter control techniques, along with the possibility of manufacturing of high rated wind turbines, has lead to commissioning of large size onshore and offshore wind farms directly connected to high voltage grid. Wind power integration, although has low carbon emission and operational and maintenance cost, poses many planning and operational problems to system operators as well as wind power generation suppliers. The reason being intermittent nature of wind power generation is due to its strong dependency on the stochastic weather variable. Accurate wind power forecast tools to mitigate the various undesirable effects, with the growing wind penetration, is very much essential. Wind power forecasts are carried for various lengths of forecast horizons based on the requirements. A short term wind power forecast is useful in dealing with the operational problems like frequency and power balance, voltage and reactive power support, and power quality issues. On the other hand, a long term wind power forecast is useful for planning and operational problems like, economic scheduling, unit commitment and spinning reserve allocation. In view of this, the first and foremost of this research work is to develop short term and long term wind power forecast tools. In the case of short term wind power forecast, a two stage statistical model taking measured wind speed and wind power outputs as inputs is developed using Adaptive Wavelet Neural Network (AWNN) for predicting wind speed, and Feed Forward Neural Network (FFNN) for non-linear mapping between wind speed forecast and wind power output. In long term wind power forecast, the Numerical Weather Prediction (NWP) system wind speed and direction forecasts available at the nearest grid point are mapped on to wind power output forecast. Incentives and subsidies turn out to be less relevant with increase in wind power penetration day by day. In such cases the only option left with wind power producers is to bid in electricity markets. This seems to be more problematic particularly in case of wind power producers participating in the day-ahead electricity market, due to intermittent wind power generation. In addition to uncertainty of wind power generation the uncertainty due to market prices, both spot and imbalance, has great impact on revenue generated in day-ahead bidding. A stochastic programming model is developed for optimal day-ahead wind power bidding considering the uncertainties due to wind power generation, and market prices. The increase in penetration levels of wind power generation has lead to imposition of the new grid code insisting wind farms to provide more and more control capabilities regarding active and reactive power outputs similar to the conventional power plants. In addition to the wind turbine acting as a reactive power source, other compensating devices like fixed or variable reactors and capacitors, along with static var compensator (SVC)/static synchronous compensator (STATCOM) are utilized to satisfy the grid code requirements. This requires an overall wind farm level dispatch centre controlling the net reactive power generation within the wind farm. For this a Hybrid Particle Swarm Optimization (HPSO) method is developed for ORPD within the wind farm. However, due to stochastic and highly intermittent nature of wind power generation, the On Load Tap Changer (OLTC) setting has to be continuously regulated in order to maintain the voltage profile with in a acceptable limits. A short term ORPD within a wind farm carried for few time steps ahead, considering the Unit Adjustment Cost (UAC) of OLTC transformer is proposed.

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***Title*** : ***Input-Series-Output-Parallel Connected Buck-Rectifiers for Traction Applications***

***Author(s)*** : ***Chaudhary Poonam***
***Roll No*** : ***Y7104096***
***Supervisor(s)*** : ***Sensarma Parthasarathi***

***Abstract***

Internationally, the most preferred network supplies for ac traction are 50Hz-25 kV and 60 Hz-25 kV. These high voltages are stepped down and rectified to a dc stage (3 kV-500 V), which either directly supplies dc motors or constitutes the input stage of traction inverters. The consequent step-down is met by a low-frequency transformer followed by a rectifier bank. This renders the system bulky and impairs the overall efficiency. Motivation of a compact and efficient traction converter has guided the research in two directions. One perspective proposes the replacement of low frequency transformers by medium-frequency transformers and the other introduces transformer-less topologies. Transformer-less topologies offer complete mitigation of the transformer, however this is achieved at the expense of compromised redundancy. The demand of redundancy and modularity is suitably addressed by medium-frequency transformer (MFT) topologies, which offer the input-series and output-parallel (ISOP) connection of the rectifier modules. Generally these modules are boost type rectifiers, which are constrained to have dc link voltage higher than the ac side. This leads to increased number of modules in series connection. Considering this, buck rectifiers (BR), which offer an inherent advantage of reduced dc voltage, may be a viable solution. However, BR topologies have not received much attention due to substantial filtering requirement on the dc side. In the first part of the work, a new method of active wave-shaping the source current for a single BR module is proposed. The method ensures rectification and attenuation of voltage in a single step, while ensuring sinusoidal, near unity power-factor source current. Exhaustive design details for the dc inductor, which forms the most critical element, are included. The second part of the work includes connection of two BR modules in ISOP configuration. Converters connected in ISOP configuration are not inherently stable. With ISOP connected ac-dc converters, an additional constraint of source-current wave-shaping is introduced. Considering this, a two-loop control scheme is proposed, which ensures rectification and attenuation of source voltage along with high quality source current. All the analytical foundations are verified through simulations and experiments. For experimental verification, a 2.4 kW, grid connected, laboratory prototype is used.

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***Title*** : ***Space Charge Phenomena in Homogeneous and Composite Polymeric Insulating Materials***

***Author(s)*** : ***Das Supriyo***

***Roll No*** : ***Y8104075***

***Supervisor(s)*** : ***Gupta Nandini***

***Abstract***

Space charge accumulates under electric field stresses in polymeric dielectrics used in insulation of power apparatus and systems. Accumulated charge contributes to degradation and deterioration of the dielectric material, especially through local field enhancement. The problem is further aggravated in composite materials, where the dielectric – dielectric interfacial region is prone to interfacial (Maxwell-Wagner) charge accumulation, as well as modified trap densities due to surface states.Insulators under operation are routinely subjected to thermal, electrical and ambient stresses, which cause aging of the material. Aging is accompanied by modified charge carrier transport, while being driven further by the charge accumulation processes. Therefore, it is important to understand the mechanism ofcharge evolution and transport within aged and unaged polymeric dielectrics. In this work, we obtain spatial mapping of charge in epoxy resin and polyethylene under applied DC fields. The Pulsed Electro-Acoustic system is principally used for charge mapping, in conjunction with conduction current measurements. Experiments are carried out on epoxy and polyethylene composites as well, to investigate the behaviour at interfaces.The materials under study are further subjected to thermal and humidity aging, in order to understand the effect of aging on charge accumulation within the volume of the material. Additionally, a bipolar charge transport model is used to simulate charge trapping under various conditions, so as to obtain an insight into the not-easily measurable physical parameters governing charge carrier transport and trapping within the volume of the dielectric e.g. barrier heights for charge injection and charge detrapping, trap density, trapping coefficients,etc.

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***Title*** : ***Dielectric Properties Of Epoxy Based Composites With Various Metal Oxide Nanofillers***

***Author(s)*** : ***Patel Riteshkumar Ratilal***

***Roll No*** : ***Y6104099***

***Supervisor(s)*** : ***Gupta Nandini***

***Abstract***

Epoxy and epoxy-based composites are preferred insulating materials in many electrical applications. Recently, various polymer nanocomposites, prepared by incorporating nano-sized fillers into a base polymer, have attracted attention. Considerable research has been undertaken in the recent past in order to explore the possibility of their use as novel insulating materials in power apparatus and system. In this work, a comprehensive study of the effect of incorporation of some metal-oxide nanoparticles viz. Al2O3, TiO2 and ZnO, on the electrical properties of epoxy is undertaken. DC conductivity and polarisation-depolarisation currents are measured. Effects of various parameters like temperature, electric field, thickness etc. are studied. The dominant polarisation mechanisms are identified in epoxy and its nanocomposites. Time domain spectroscopy, as well as frequency domain spectroscopy, is performed to measure the permittivities of the materials at different frequencies. While dipolar polarisation is found to be the dominant mechanism irrespective of temperature, the presence of absorbed moisture is seen to initiate Low Frequency Dispersion (LFD) at high temperatures. Incorporation of nano-fillers is seen to increase DC conductivity as well as permittivity. Dielectric breakdown strength is studied using Weibull statistics, and is seen to fare comparably well with respect to pure epoxy as well as composites with micro-sized fillers. Effect of pre-processing the fillers with GPS is also studied. The dispersion of the particles is verified using High resolution Transmission electron Microscopy (HRTEM). A quantitative method is proposed to characterise dispersion in nanocomposites

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***Title*** : ***Switched Boost Inverter: Analysis, PWM Control, and Its Application to DC Nanogrid***

***Author(s)*** : ***Adda Ravindranath***

***Roll No*** : ***Y9404061***

***Supervisor(s)*** : ***Joshi Avinash&Mishra Santanu***

## *Abstract*

The thesis proposes a single-input, two-output power electronic converter called "switched boost inverter (SBI)." The SBI can generate a dc output and an ac output simultaneously from a single dc input. The rms value of its ac output voltage can be either higher or lower than the available dc input voltage. Unlike a traditional voltage source inverter (VSI), the SBI allows shoot-through state of the inverter bridge. So, it does not require dead-time to prevent the shoot-through in the inverter phase legs. Also, it has better reliability when compared to the traditional VSI. The thesis describes the circuit development of the SBI along with its steady state and small signal analyses. A detailed comparison of the SBI with traditional power electronic converters is also given in the thesis. Also, different pulse width modulation (PWM) algorithms suitable for the single-phase and three-phase SBI have been proposed. These techniques are named as "Variable frequency PWM (VFPWM) technique," and "Constant frequency PWM (CFPWM) technique." Experimental prototypes of the single-phase SBI and three-phase SBI, have been built to verify the analysis and PWM control techniques, described in the thesis. Finally, the thesis proposes the single-phase SBI as a power electronic interface in a residential nanogrid. A closed loop control system of single-phase SBI, in synchronous reference frame, has been developed for the SBI based nanogrid operating in both standalone and utility connected modes. The control system has also been implemented using a digital signal processor (DSP). The performance of the SBI based nanogrid and its closed loop control system have been verified using both simulation and experiments, for different operating conditions of the nanogrid.

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***Title*** : ***Studies on Dielectric Resonator Antenna for Wide/Multi-band Applications Using Permittivity Variation Along Three Orthogonal Directions***

***Author(s)*** : ***Chaudhary Raghvendra Kumar***

***Roll No*** : ***Y9104096***

***Supervisor(s)*** : ***Srivastava K V&Biswas Animesh***

## *Abstract*

Dielectric resonators (DRs) have been used as high Quality (Q) factor elements in microwave applications e.g. filter and oscillator. Due to high permittivity and high Q-factor dielectric resonators offer a more-compact alternative to waveguide technology. In these applications dielectric resonators have been usually treated as energy storage elements rather than radiating elements. Later it has been proved that when these resonators with low permittivity are kept in an open environment, then the power is lost in the radiated fields and the radiation Q-factors of lowest order mode is reduced. This behavior leads them to be used as antenna elements. Dielectric resonator antenna (DRA) offers many attractive features like no inherent conductor loss that leads to high radiation efficiency, simple coupling scheme, and different radiation characteristic can be obtained by exciting different modes of DR antenna. The bandwidth enhancement in DRA is the most interesting area for researchers and engineers. There are several techniques developed to achieve this e.g. using different coupling mechanisms, different shapes, DRA loaded with patch and using stacked DRs etc. The concept of stacked DRs can also be used for achieving wide bandwidth. In the case of two or more segments, the bandwidth enhancement is done through exciting the same mode in each layer at different frequencies. Therefore, the overall bandwidth is a combination of the individual bandwidth of each layer. The proposed work discusses about the input impedance bandwidth enhancement by using permittivity variation with conventional structures. The study has been done for permittivity variation along axial direction in cylindrical, half-split cylindrical and rectangular DRA whereas permittivity variation in radial direction has been studied in half-split Cylindrical DRA. Along with this, dual and triple band characteristics are achieved with permittivity variation along azimuth direction in cylindrical DRA. This thesis also presents a new dumbbell-shaped DRA for wideband application which is a special case of multi-layer multi-permittivity in axial direction while maintain the same permittivity in proposed structure. An interdisciplinary study has also been presented for synthesis and characterization of ZST-Epoxy microwave composites and its possible application in stacked DRAs for wideband applications. To validate simulation results, fabrication has been done of each proposed structure. Good agreement has been observed between simulated and experimental results

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***Title : A Device/Circuit Co-Design Study on Metal Source/Drain SOI MOSFET for Nanoscale Mixed-Signal Circuits***

***Author(s) : Patil Ganesh Chintaman***
***Roll No : Y7204062***
***Supervisor(s) : Qureshi Shafi***

***Abstract***

Over the last decade due to aggressive device scaling silicon-on-insulator (SOI) CMOS technology has seen a continuous pace in performance improvement for nanoscale CMOS circuits. Today, towards the end of international technology road map for semiconductors, SOI CMOS technology is suffering from the fundamental challenges such as self-heating (SH) effect, process induced device parameter variability, excess source/drain (S/D) series resistance (RSD), short-channel effects (SCEs), excess parasitic capacitances, excess leakage currents and the requirement of shallow junctions. In this thesis, to overcome the challenges involved in metal S/D SOI CMOS technology, novel device structures are proposed by modifying the existing structure of dopant-segregated Schottky barrier (DSSB) SOI MOSFET. The device structures proposed in this work are 1)delta-doped partially insulated DSSB SOI (DSSB Pi-OX-delta), 2)underlap channel DSSB SOI 3)dual-k spacer underlap channel DSSB SOI and 4)asymmetric drain (ASD) underlap channel DSSB SOI MOSFETs. In addition to this, the mixed-signal circuit performance of the proposed devices is investigated by performing the extensive mixed-mode device/circuit simulations. In proposed DSSB Pi-OX-delta structure, buried oxide (BOX) surrounds only the metal S/D which creates an opening under the channel through which the heat generated in the channel can be easily dissipated into the substrate. In addition to this, the use of delta-doping under the channel not only cuts-off the path of the fringing field lines arising from the drain but also improves the high frequency performance of the device. Further, since the presence of BOX opening reduces the stringent requirement of uniformity in thin Si film and the screening effect due to delta-doping reduces the random dopant fluctuations, the process induced parameter variations in the proposed device are also low as compared to scaled DSSB SOI MOSFET. In second proposed device i.e. underlap channel DSSB SOI MOSFET, although in strong inversion region the reduced on-state drive current (ION) reduces analog/RF performance, in weak inversion region both digital and analog/RF figures of merit of the proposed device are improved over the conventional overlap channel structure. This clearly shows that employing an underlap channel in DSSB SOI MOSFET makes it a suitable candidate for low-power mixed-signal circuits. Although underlap channel DSSB SOI MOSFET seems to be a promising device for low-power circuits, the reduced ION in strong inversion region can affect the high frequency performance of the device. To alleviate this problem Si3N4:HfO2 dual-k spacer underlap channel DSSB SOI MOSFET is proposed. In this device increased fringing electric field due to high-k inner spacer layer not only improves the ION but also reduces OFF-state leakage current (IOFF) of the device. Further, to overcome the trade-off between scalability and high frequency performance of DSSB SOI MOSFET, a novel ASD underlap DSSB SOI structure is proposed, in which overlap at the source and underlap at the drain are created by varying the spacer thickness of the device. In the proposed ASD underlap structure the use of thin spacers at the source forms an overlap channel and the thick spacers at the drain forms an underlap channel at the drain. The results of this implementation show that, in comparison to symmetric source/drain overlap and underlap channel structures, the presence of overlap at the source and underlap at the drain of ASD underlap structure not only reduces IOFF, SCEs and the GIDL but also improves the digital and analog figures of merit of the DSSB SOI MOSFET.
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***Title : Reputation Management System in Peer to Peer Networks***
***Author(s) : Gupta Ruchir***
***Roll No : 10104121***
***Supervisor(s) : Singh Yatindra Nath***
***Abstract***

Peertopeer networks generally comprise of rational users. This leads to the problem of free riding, i.e, users want to use resources from network but do not want to contribute back to the network. This problem is theoretically explained on the basis of 'Prisoners' Dilemma'. The problem of free riding can be overcome by providing suitable incentives for sharing. For proper provisioning of incentives, some kind of reputation management system is required. Peertopeer networks don't have any central control or repository. Hence reputation management system should perform all the tasks in distributed fashion. Large size of peertopeer networks makes the reputation management more challenging task. When these kind of systems are implemented, peers try to deceive such systems. Whitewash and collusion are two ways to deceive the reputation management system. Here whitewash implies the tendency of an peer to change its identity to avoid the bed reputation. Whereas collusion means forming the groups to deceive the system. Generally in peertopeer network many users have common interests but they may not necessarily form a group. The resource query network and reputation network integration may lead to an efficient system. Probabilistic allocation based on reputation may be a good option for allocation of resources because in this case nodes that don't have very good reputation about each other, may allocate some resource with finite probability. This avoids disconnect between them. In this thesis, different issues in different reputation management systems has been explored. New algorithms for making a complete reputation management system has been proposed. Algorithm for resource allocation on the basis of reputation is proposed. The main objective of the thesis is to identify the limitations of existing reputation management system and to solve them by proposing new algorithms that are simple and light weight in implementation

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***Title*** : ***Rumor Dynamics and Inoculation of Nodes in Complex Networks***

***Author(s)*** : ***Singh Anurag***

***Roll No*** : ***Y8204062***

***Supervisor(s)*** : ***Singh Yatindra Nath***

## *Abstract*

Online social networks have become a default tool for communication and spread of information. Many researchers have been investigating the information diffusion process in them. The contacts in these social networks usually form a complex network. Thus the problem basically is the information diffusion in them. These networks are usually characterized by nodal degree distribution following either power law or Poisson law, smaller average path length, and higher clustering coefficient. When a complex network follows Poisson degree distribution, it is considered as a homogeneous network i.e., most of the nodes have degree closer to average degree of the network. When it follows the power law, the network is heterogeneous with large degree variation. Rumor is an information whose diffusion is not desirable. Taking cues from epidemic spreading models, models for rumor spread have also been proposed in literature. One of the earliest model called susceptible-infected-removed (SIR) was given by Daley-Kendal. Later Maki-Thompson gave a variation of the same. These model never considered the underlying topology of the network. All the population in the network for these models can be divided into three categories - ignorants, spreaders and stifler. The models assume that the rumor propagates through pairwise contacts of the spreaders with ignorants. We have introduced a new parameter called acceptability factor in the model and have investigated the impact of this on the rumor spreading. We have further modified the model to incorporate the links with varying tiestrengths. The tie strength models the affinity between the pair of nodes for rumor spreading. We have further considered the spreading rates which change nonlinearly with increasing nodal degree. All the new models have been considered for small world network which are homogeneous, as well as scale free network which are heterogeneous. Both the scenarios when nodal degrees of neighbors are not correlated, and when they are correlated, have been incorporated in our models. In order to control the rumor spread, the inoculation of nodes is an effective technique. We have looked into the random, targeted, and neighbor inoculation mechanisms for their effectiveness. We have further looked into selection of nodes for inoculation on the basis of structural centrality conditions. We have observed that the rumor spread can be effectively controlled by inoculation of nodes if chosen judiciously

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***Title*** : ***Cooperative Human Finger Motion Analysis and Optimal Design of a Three-finger Exoskeleton***

***Author(s)*** : ***Orlando M Felix***

***Roll No*** : ***Y6204064***

***Supervisor(s)*** : ***Behera Laxmidhar&Dutta Ashish; Saxena Anupam***

## *Abstract*

The focus of this thesis is on the understanding of human finger behavior in cooperative, task oriented motion and subsequently, optimal design and development of a three finger exoskeleton. Since human digits can perform a variety of possible motions, accomplishment of the aforementioned goals for rehabilitation purpose is challenging. Cooperative behavior of human thumb, index and middle fingers in rotational and translational object manipulations are studied. It is found that the thumb and middle finger are active, while the index finger operated passively while manipulating small objects in cooperative rotational motion. Thereafter, redundancy resolution of these digits in translation motion is performed through an inverse kinematic model by instantly varying a single, redundancy parameter. It is observed that humans actively utilize instantaneous manipulability measure as a secondary subtask of following the given desired translation tip trajectory. This behavior is accurately captured by an inverse kinematic model based on a single, time varying redundancy parameter. The joint angles get determined unambiguously though the redundancy parameter is shown to depend on the instantaneous finger configurations and to attain negative values. Finally, an optimal three finger exoskeleton is designed to track the human finger motion accurately.

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| ***Title*** | ***:*** | ***Base Station Positioning, Nodes' Localization and Clustering Algorithms for Wireless Sensor Networks*** |
| ***Author(s)*** | ***:*** | ***Tripathi Rajiv Kumar*** |
| ***Roll No*** | ***:*** | ***Y7104097*** |
| ***Supervisor(s)*** | ***:*** | ***Singh Yatindra Nath&Verma Nishchal Kumar*** |

## *Abstract*

The main objective of the thesis is to investigate the mechanisms to conserve and balance the energy consumption in two tiered wireless sensor networks. In this thesis, the problems related to above aspect have been investigated. The first issue is where to place base station in a wireless sensor network. In this work, we have considered path loss as well as geometrical parameters for defining new optimal base station location. An algorithm to estimate the sub-optimal base station position has also been proposed. Anchor free localization is performed in a single hop wireless sensor network. Anchor free localization is important for localizing all the wireless nodes without using GPS. Average of distances is used for the first time to localize the reference nodes in a wireless sensor network. Also two different methods have been proposed to minimize as well as to balance the energy consumption among the nodes in a wireless sensor network

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*Title* : *Quantum Well Intermixing Applications in Waveguide Photodiodes*

*Author(s)* : *Bhowmick Tathagata*
*Roll No* : *Y5404066*
*Supervisor(s)* : *Das Utpal*

## *Abstract*

The work presented here uses quaternary alloys to design multi-wavelength waveguide photodiodes for Coarse Wavelength Division Multiplexing (CWDM) applications. Bandgap engineering has been done by the process of Quantum Well Intermixing (QWI) in MQWs for selective wavelength detection. The design of integrated PIN waveguide photodiodes for CWDM applications has been presented. Impurity Induced Quantum Well Intermixing (IIQWI) in InGaP/GaAs MQWs gives red shift and values of the diffusion constant DoIn-Ga and DoP-As measured in earlier works have been assumed to be applicable for InGaAsP/InP MQWs. Using the available diffusion constant values, Fluorine dose dependant QWI has been modeled and it is seen that the band gap of (15nm)InGaAsP/(15nm)InP can be tailored (red shifted) to align with the CWDM wavelengths. The band gap shift of MQWs annealed at different conditions has been measured by using waveguide absorption and photoluminescence measurement and it has been seen that blue shift is obtained instead of the expected red shift. The blue shift is attributed to the post implant anneal P out-diffusion, which has been later eliminated by ZrO2 cap anneal. However, it was found that Impurity Free Quantum Well Intermixing (IFQWI) occurs due to ZrO2 and the IIQWI and IFQWI cannot be decoupled. Hence with a different design, the CWDM photodiode fabrication may be possible by combining ZrO2 cap IFQWI and F dose dependant IIQWI. It has also been concluded that ZrO2 based IFQWI alone can be used to fabricate a single wavelength waveguide photodetector. For the fabricated Schottky waveguide photodiode the measured responsivity is 1.2mA/W at 1510nm. From the measured spectral responsivity it has been observed that the cut-off wavelength of 1510nm matches well with the band gap of the MQWs verified by photoluminescence

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***Title*** : ***Combinational Load Shedding Methodology for Power Distribution Systems***

***Author(s)*** : ***Singh Deepak Kumar***

***Roll No*** : ***Y6204061***

***Supervisor(s)*** : ***Kalra Prem Kumar&Shekhar Rajiv***

## *Abstract*

The primary objective of this research has been to devise an algorithm for load shedding, which is an amalgamation of both the technical and economic criteria. The formulated load shedding model not only minimizes the economic loss of customers but also ensures that the optimum solution will incorporate technical constraints related to current overload and frequency imbalance. Load shedding optimization will help planners to shed load strategically during generation deficiency or sudden overshoot in load or demand. To do so they need demand and supply data from customers and generators respectively. The performance of the proposed methodology will be heavily dependent upon the accuracy of data. So to help planners, a short term load forecasting method has also been clubbed with the primary objective. This forecasting algorithm is based on neural network and is therefore more accurate and robust than traditional load forecasting methods. Using the proposed load forecasting method the planners can forecast the demand supply gap in advance and then use the load shedding methodology to avert any blackouts. Four important concepts have been incorporated in the proposed methodology. 1. Dynamically upgrading the loss functions of the customer to avoid continuous penalization of select customer sectors (agriculture, industry etc.). 2. Managing the overflow in the lines after load curtailment. 3. Keeping the system frequency in limit by managing reactive power flow. 4. A neural network based algorithm for short term load forecasting, based on ingenuously derived error metric

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| ***Title*** | ***:*** | ***Simulation Studies on Understanding the Effect of Defects, Doping and Moisture on Electron Transport Properties of SiCNTs: An ab-initio study*** |
| ***Author(s)*** | ***:*** | ***Choudhary Sudhanshu*** |
| ***Roll No*** | ***:*** | ***Y6204069*** |
| ***Supervisor(s)*** | ***:*** | ***Qureshi Shafi*** |

## *Abstract*

In recent years, there has been intense interest in carbon nanostructures and in theoretical analysis of such materials. Theoretical analysis has led to evolution of what is now known as computational nanoelectronics. Based on tubular forms of carbon atoms (CNTs), tubular form of silicon carbide (SiCNTs) have been experimentally and theoretically investigated. SiCNT is found to have some unique properties that show its advantage over CNTs for devices designed to operate at high temperature, high power and in harsh environments. SiCNTs are normally semiconductors except small diameter tubes which are metallic. Significant advances have been made in tuning the electronic properties of CNTs and SiCNTs by introducing defects such as deformation, vacancy defects and doping. The present work is concerned with finding the effect of radial and axial deformation, introduction of single and double vacancy defects, co-doping SiCNTs with boron (B) and nitrogen (N) impurities, and adsorption of water molecules on electron transport properties of SiCNT. The study was carried out using a commercial DFT-NEGF package, Atomistix ATK from Quantum Wise A/S.

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*Title* : *Design and control of Matrix Converter for regulated 3-phase power supply and voltage sag mitigation for linear loads*

*Author(s)* : *Dasgupta Anindya*

*Roll No* : *Y6104094*

*Supervisor(s)* : *Sensarma Partha Sarathi*

## *Abstract*

One of the major research goals in power electronics has been reduction in the size of passive elements and aiming towards more compact converters. Matrix Converters offer higher power density for 3-phase AC - AC conversion than conventional two stage conversions realized through two converters interlinked by an energy storage element. Despite this advantage, academic and industrial research interest in Matrix Converter have been largely confined to motor drive applications. For power system applications, voltage source inverters with their bulky electrolytic capacitors still remain the primary choice. Over the last few years, there has been an emerging interest towards using Matrix Converters in power system applications. Most of these applications demand faster dynamic performance than the high inertial industrial drives. Absence of any intermediary energy storage element makes Matrix Converter a dynamically tightly coupled input-output unit. In addition to a second order ripple filter at input side, regulated output voltage required in most of the power system applications demands another set of ripple filter. Under these circumstances, overall system design, particularly controller design becomes challenging. In this context, reported control techniques either rely on state feedback approach which fails to provide adequate physical insight or feed-forward based techniques with an upper bound on active power transfer capacity. This thesis is a part of the larger effort to expand the application domain of Matrix Converter to power systems. Two target applications for synchronous systems have been dealt with - regulated 3-phase voltage supply and voltage sag mitigation. The objective of the thesis has been subsequently categorized into the following -developing a dynamic model which provides adequate design insight, filter design and devising a control scheme. The low frequency dynamic model is first analyzed for regulated voltage supply assuming balanced system. The system is modelled in the synchronous dq domain, linearized around an operating point. The input output variables are related by non-diagonal transfer function matrices. Individual sub-transfer function matrices are sequentially investigated and it is shown that depending on the input power, input voltage and filter parameters a possibility of appearance of a set of right half zeros exist. The design of filters are considered next. Apart from general issues like ripple attenuation, regulation, reactive current loading and filter losses, additional constraints which may be imposed by dynamic requirements and commutation are also addressed. In the third stage, voltage controller design is detailed for 3-phase regulated voltage supply. In dq domain, output voltage control represents a multi variable control problem. The control problem is reduced to a single variable one while retaining all possible right half zeros, thereby preserving the internal stability of the system. Consequently, standard single variable control design technique has been used to design a controller. The analytically predicted dynamic response has been verified by experimental results. The system could be operated beyond the critical power boundary where the right half zeros emerge. Finally, the developed control approach has been extended to voltage sag mitigation with adequate modifications. A 3 wire linear load has been considered. Both symmetrical and asymmetrical voltage sags have been considered. Experimentally obtained response time for sag mitigation was found to be less than the power supply hold up time of most of the sensitive equipments

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***Title*** : ***A New Probabilistic Transmission Expansion Planning Methodology in a Restructured Market with Demand Uncertainty***

***Author(s)*** : ***Gupta Neeraj***

***Roll No*** : ***Y6104097***

***Supervisor(s)*** : ***Kalra Prem Kumar&Shekhar Rajiv***

***Abstract***

Transmission expansion planning (TEP) is of prime importance for reducing generation cost, minimizing consumer cost and improving the quality of power supply. Indeed, previous TEP procedures have multiple shortcomings: (i) capacity of new alternative transmission lines are specified a priori, (ii) the followed procedure of reliability calculation does not ensure electrical laws (such as minimum-cut maximum-flow (MCMF)) and iterative in the nature based on optimization (such as DC-load flow based load curtailment strategy (LCS)), (iii) generation location and output scenarios have not been considered, (iv) lack of implementation of economic power flow, (v) marginal cost theory (iv) cost of unutilized generation capacity (v) cost of wheeling loss and (vi) effect of market based simulations. In this thesis, we incorporated above shortcomings by improving, objective function, and congestion management based Roulette wheel selection model along with fast reliability calculation model. The combinatorial algorithm albeit offers the solution for deterministic as well as probabilistic TEP subject to noticeable shortcoming. From the result of planning process we found that update of low capacity of transmission lines are removed by pruning the huge alternative transmission lines, which may be the cause of uneconomical investment. Further to make TEP process efficient generation expansion planning is incorporated with TEP simultaneously, based on market analysis. Results show that composite TEP (HL-II) gives best investment plan towards maximizing social welfare. The results suggest the optimal location of new generators for the investors as well update of old generating units simultaneously with the investment in the network.

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***Title : Bidirectional Optimal Battery Charging System***
***Author(s) : Singh Rajeev Kumar***
***Roll No : Y9104097***
***Supervisor(s) : Mishra Santanu Kumar***

## *Abstract*

Batteries are essential part of many diverse systems such as micro-grids, automotive, and portable electronics. Depending upon the application, the type and the size of the battery varies, e.g., Li-ion batteries are used for high power applications [1]. Many systems such as automotive systems prefer to have more than one battery for load sharing and added back up. Such diversification in applications results in the large demands of a bidirectional universal battery charger that is capable of charging every type of batteries with the given voltage along with its optimum charging current requirement. This dissertation presents a switching converter based optimal bidirectional battery charger implemented both in the analog and field programmable gate array (FPGA) based digital domain. For the analog implementation, a novel feedback-clamped average current mode controller is used for the optimal charging of a battery. Synchronous buck converter (for scaled down prototype) and bidirectional coupled inductor boost converter (for upgraded prototype) are used to implement the power converter stage. The charging circuit is universal from battery voltage view point, i.e., can be applied to any battery with given voltage rating and adaptive from optimum charging current requirement point of view, i.e., can adapt to the given (given by the manufacturer of the battery) optimum charging current of a battery. The proposed charger acts in constant current (CC) mode, i.e., as a controlled current source, for low battery SOC and in constant voltage (CV) mode, i.e., as a controlled voltage source, for the battery SOC near 100%. The proposed charger ensures smooth (i.e. continuous) transition from CC to CV without the need of any additional operating control circuits unlike the conventional optimal battery chargers. The regulation loop is clamped in the proposed charger. This makes the charger feedback controlled in all the modes of operation, i.e., CC mode, CV mode, and even during the transition from CC to CV. The charger is capable of adapting to all the existing optimum battery charging techniques, i.e., CC-CV charging (two-mode charging), pulse charging and reflex charging. It is capable of testing the chargeability of a deeply discharged battery as well. The performance of the charger (implemented in the analog domain) is verified through experiment and simulation on 20 W scaled down prototype and 250 W upgraded prototype. The proposed charger (implemented in the analog domain) is verified on 12 V-32 Ah and 12 V-7 Ah lead acid batteries as well. For implementation in the digital domain, hysteretic control scheme is selected and a new carrier generation based hysteretic modulator is proposed. Synchronous buck converter is used in the power stage. With the help of a simple analog comparator (for predicting the status of Vphase) and one analog-to-digital conversion (ADC) IC (for output voltage sensing), the proposed digital modulator generates a piecewise linear synthetic ripple inside the (FPGA) based digital system. This synthetic ripple is then added to the output voltage to generate carrier for the hysteretic comparator. The proposed modulator does not require direct inductor current sensing. With the proposed digital modulator, the optimal charging of a battery is performed without the need of direct inductor current sensing. The proposed digital charger is validated through simulation and experiment on a 20 W scaled down prototype. The performance of the optimal digital battery charger is verified on a real 6 V-4.5 Ah lead acid battery as well. Thus, the present dissertation work develops a bidirectional optimal battery charger. The charger is studied and implemented both in the analog and in the FPGA based digital domain

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***Title*** : ***Estimation of Stationary and Time-Varying Harmonics in Emerging Power Systems***

***Author(s)*** : ***Jain Sachin Kumar***
***Roll No*** : ***Y9204068***
***Supervisor(s)*** : ***Singh Sri Niwas***

## *Abstract*

The advancement of high-power semiconductor devices and converter technologies opened up new vistas in the area of power engineering. As a result, the proportion of power-electronics-based nonlinear loads and devices in the power system has increased drastically. With the growing share of these solid state switching devices the quality of power supply has been deteriorating to the alarmingly low levels. Waveform distortion, represented as the set of harmonics and interharmonics, is the most vital concern among many power quality problems. High level of harmonic and interharmonic in the power supply causes loss of substantial amount of revenue in terms of increased losses in the transmission lines, cables and equipments; failure of equipments due to resonance; malfunction of control and protection systems; rapid ageing of equipments; etc. Accurate and fast estimation of harmonics is a fundamental requirement for monitoring, analysis and/or control of power system harmonics, which enables realization of the smarter and cleaner grid with effective harmonic source identification, improved active filter control for mitigation of harmonics, smart meters for harmonics pollution metering, etc. In this dissertation, estimation of signal parameters via rotational invariance technique (ESPRIT) and adaptive wavelet neural network (AWNN) based methods are proposed for precise estimation of stationary and time-varying harmonics. The proposed exact model order ESPRIT (EMO-ESPRIT) method and the Adaptive Time-Efficient ESPRIT (ATE-ESPRIT) method are capable of estimating frequency, amplitude and initial phase angles of the distorted supply with very high accuracy. On the other hand, the AWNN and ESPRIT-Assisted-AWNN (EA-AWNN) methods estimate the dominant harmonics with only half-cycle data samples. The EMO-ESPRIT and AWNN methods are suitable for stationary signals, whereas, the ATE_ESPRIT and EA-AWNN methods are capable of estimating the time-varying harmonics also. The robustness of the proposed algorithms has been investigated on the variety of simulated signals. The performance of these methods has been verified with the actual power supply signal and synthetic time-varying signals (in the Opel-RT), which are acquired in the laboratory using the developed data acquisition setup. The results confirm the superiority of the proposed methods over existing methods

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***Title*** : ***Learning based near-optimal redundancy resolution schemes for visually controlled robot manipulators***

***Author(s)*** : ***Patchaikani Premkumar***

***Roll No*** : ***Y6204067***

***Supervisor(s)*** : ***Behera Laxmidhar***

***Abstract***

Visual feedback plays a key role in the human operation and it provides dynamic information about the environment for manipulating the objects. Humans can effectively manipulate the object in an unstructured environment, since the hands are redundant. It is presumed that such visual dextrous manipulations are possible through continuous learning using the reinforcement signal obtained from the environment. These observations have lead to the development of learning based visual automation of robotic arms which enables such systems to perform well in both structured and unstructured environments. This thesis work is concerned with the development of learning based visual control algorithms for a 7 degree of freedom redundant manipulator controlled through stereo-vision. This thesis work primarily focuses on image based visual servoing, and the joint angular velocity is computed directly from image features to integrate visual servoing and redundancy resolution in a single framework. The control algorithms developed in this thesis work can be summarized as follows: 1. Combined estimation of pseudo-inverse of kinematic and image Jacobians using Kohonen's self-organizing map 2. Adaptive critic based near-optimal redundancy resolution scheme while minimizing a global cost function 3. Reinforcement learning based optimal redundancy resolution for vision space trajectories 4. Learning based dynamic visual servoing with critic based torque optimization This thesis work contributes to push the state-of-the art as follows: 1. It is shown that the nonlinear ill-posed inverse kinematic relationship of the redundant manipulator can be approximated as a cluster of locally valid linear inverse Jacobian maps at various operating zones using KSOM based learning. 2. KSOM based kinematic control algorithm is generalized to learn particular inverse Jacobian by expressing the desired additional task as an instantaneous cost function in weighted norm formulation. 3. A novel visual kinematic control algorithm has been proposed where near-optimal redundancy resolution of a global cost function is achieved using adaptive critic network. 4. A novel online policy iteration scheme is proposed for optimal control of continuous-time input affine systems. The proposed scheme does not require the knowledge of the internal dynamics of the system and guarantees convergence to optimality while controlling the plant offline.

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***Title : Swarm intelligence based dg and capacitor planning in distribution networks***

***Author(s) : Jain Naveen***
***Roll No : Y9104094***
***Supervisor(s) : Singh SN& Srivastava SC***

***Abstract***

Increasing energy demand and depleting fossil fuels, associated with environmental pressure, has prompted electric utilities, worldwide, to explore increased use of the distributed energy resources. Distributed Generations (DGs), as an alternative for the capacity addition, offer several benefits to the system. The electrical characteristics of the DGs differ significantly in terms of real and reactive power generation and control. The maximum benefits can be extracted from a DG, if it is planned optimally. Optimal planning of multiple DGs and capacitors, based on single as well as multiple objectives, has been proposed in this thesis. The planning studies require several load flows to be run, treating the DG buses as P-Q or P-V nodes. In distribution systems, handling multiple DGs as P-V nodes with the conventional load flow methods, is a tedious task. Hence, a heuristic approach based distribution load flow has been proposed to effectively handling multiple DGs as P-Q or P-V nodes. Optimal placement of the multiple DGs, of different sizes, improve the distribution network performance but increases the associated cost, resulting in an optimization problem with contradictory objectives. A method to determine the best trade-off between the DG size and network performance, utilizing Multi-Objective Particle Swarm Optimization (MOPSO) method, has been proposed considering DG locations at the voltage critical buses. The selection of type of DGs (renewable/non-renewable) is an important factor in their planning. The proposed planning of the DGs has considered their intermittent nature and various system constraints, such as line current limit and bus voltage limit. Further, a Probabilistic Load Flow (PLF) method has been developed to incorporate randomness in the loads as well output of the DG. A sensitivity based approach has been utilized to avoid the system constraint limit violations. Planning of the DG, with or without back-up supply, may be risky investment under the electricity market scenario. An approach for viability analysis of the DG planning, under bi-lateral and competitive market operation using net present value analysis, has been developed incorporating yearly load growth as well as inflation in the market price. The effectiveness of the various proposed algorithms have been established on several practical test systems, representing small size as well as large size distribution networks

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***Title*** : ***Development of strategic bidding of supplier and buyer in electricity markets***

***Author(s)*** : ***Jain Arvind Kumar***

***Roll No*** : ***Y7104091***

***Supervisor(s)*** : ***Srivastava S C&Singh Sri Niwas***

***Abstract***

Suppliers in electricity market try to maximize their profit through strategic bidding. However, they are exposed to various physical and financial risks due to uncertainties, like load forecasting error, transmission congestion, rivals' bidding behavior etc. Lack of proper planning by the market participants can lead to huge financial risk. A Bi-Level Multi Objective Optimization Problem (BLMOOP) has been proposed to develop the bidding strategy of a supplier keeping risk below tolerable limit. The bidding strategy problem is essentially an optimization problem. However, the type of bidding model, consideration of technical and regulatory constraints, probabilistic estimation of system demand, and estimating other participants' bid, require a nonlinear stochastic solution approach. Artificial Bee Colony (ABC) algorithm, a relatively new evolutionary computation approach which has several advantages over the similar population based heuristic methods, has been used for developing the optimal bidding strategy of supplier in electricity market. In addition, a method to optimize the bidding decision of a supplier, considering both unconstrained and constrained market situations, has been developed. Market splitting based congestion approach using bi-level optimization model has been suggested to develop the bidding strategy of the supplier. Several electricity markets utilize both the day ahead market and the real time balancing market to keep balance between generation and demand in the system within the delivery hours. A bi-level optimization problem has been proposed to obtain the optimally coordinated bidding strategy of a supplier, considering rivals' bidding behavior, inter temporal constraints, and multi period auction. This module develops the bidding strategy of a supplier such that its total profit from the day ahead and the balancing energy markets is maximized. A new optimization formulation for developing the optimal bidding strategy of an industrial buyer has also been proposed based on Price Responsive Demand Shifting (PRDS), with and without considering the transmission congestion, for hourly day-ahead electricity markets

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***Title*** : ***Characterization of Top Contact Pentacene Organic Thin Film Transistors***

***Author(s)*** : ***Singh Vinay Kumar***

***Roll No*** : ***Y5104084***

***Supervisor(s)*** : ***Mazhari Baquer&Iyer S Sundar Kumar***

***Abstract***

Organic thin film transistors (OTFTs) are being actively pursued because of their potential for low cost fabrication of large area circuits in applications such as active matrix flat panel displays, smart cards, radio frequency identification tags, etc. on substrates such as glass, plastic, fiber and paper. Accurate and reliable measurement of device parameters is essential to understand device behavior, its limitations and eventually to optimize its performance. The aim of this thesis is to develop improved characterization techniques for organic thin film transistors. The thesis describes four new techniques in this direction which include: In presence of gate leakage through polymer dielectric in organic thin film transistors (OTFT) prevents accurate estimation of transistor characteristics especially in sub threshold regime. To mitigate the impact of gate leakage on transfer characteristics and allow accurate estimation of mobility, threshold voltage, subthreshold slope and on/off current ratio. A measurement technique that is less sensitive to gate leakage current is proposed.; New method for the measurement of source resistance in top contact organic thin film transistor. The method uses an additional contact adjacent to the source to sense the channel voltage at the source end. This allows the source resistance to be directly estimated from a single device structure. The conventional method of measurement of linearly extrapolated threshold voltage in organic film transistors does not yield a unique value due to gate dependence of field mobility. An improved method of extraction is described which does not rely on quadratic dependence of current on gate voltage. The thesis describes a combination of simulation and experimental measurements to validate the new characterization techniques. The effect of scaling of poly(methylmethacrylate) (PMMA) and cross-linkable poly(4-vinylphenol) (PVP) polymer dielectric thickness on field effect mobility in top contact pentance organic thin film transistors was investigated. The thesis describes a combination of simulation and experimental measurements to validate the new characterization techniques

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|---|---|---|
| ***Title*** | ***:*** | ***Effects of Single Walled Carbon Nanotubes on the Morphological and Optoelectronic Properties of Poly-3(hexylthiophene) Based Solar Cells*** |
| ***Author(s)*** | ***:*** | ***Mallajosyula Arun Tej*** |
| ***Roll No*** | ***:*** | ***Y4104100*** |
| ***Supervisor(s)*** | ***:*** | ***Iyer S Sundar Kumar&Mazhari Baquer*** |

***Abstract***

Semiconducting polymers have the potential to be used for low-cost and large-area flexible solar cells. At present, the efficiencies of these solar cells are relatively low because the polymers have limited range of solar spectrum absorption, high exciton binding energies, low exciton diffusion lengths, and low charge carrier mobilities. Single walled carbon nanotubes (SWNTs), on the other hand, have excellent properties like high carrier mobilities, high aspect ratios etc., which in principle, can be used to overcome some of the disadvantages of semiconducting polymers. In this thesis, the effect of blending SWNTs (having considerable metallic characteristics) with a semiconducting polymer (poly-(3-hexylthiophene) (P3HT)) on the thin-film optoelectronic and morphological properties and on single layer device performance has been analyzed. A device fabrication method has been developed without modifying the side-wall energetics of SWNTs; such that the properties of SWNTs can be used to advantage for a P3HT based system. Using this, device structures with two thicknesses have been fabricated using buffer layers (to minimize the effect of large SWNT bundles) and low work-function cathode (to increase the built-in field in the devices). SWNTs were incorporated in P3HT:[6,6]-thienyl C61 butyric acid methyl ester (PCBM) bulk heterojunction solar cells which almost doubled the device efficiencies - by improving the surface morphology and by helping in effective charge extraction from the devices. At low concentrations, SWNTs do not affect the photoluminescence quantum efficiency. Low-frequency capacitance characteristics show that SWNTs do not affect the built-in voltage of P3HT:PCBM devices. SWNTs reduce the bimolecular recombination of photogenerated carriers, which dominates the device performance at high light intensities. Impedance spectroscopy is utilized to show that this is in contrast to their role with respect to dark injection current where they reduce effective carrier lifetime. Thus, the SWNTs perform a dual role – increase charge extraction during operation in the presence of light and increase the rate of removal of dark injected carriers. They also tend to reduce the dispersiveness of charge transport. In short, even though the SWNTs with metallic properties do not generate excess carriers, they can still be very useful in improving the efficiency of extraction-limited organic solar cells.

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***Title*** : ***Waveguide Gratings for CWDM by Impurity Induced InGaAsP/InP Quantum Well Intermixing***

***Author(s)*** : ***Sonkar Ramesh Kumar***
***Roll No*** : ***Y3104118***
***Supervisor(s)*** : ***Das Utpal***

***Abstract***

Impurity Induced Quantum Well Intermixing (IIQWI) offers an important advantage of post-growth modification of band gap, absorption, and refractive index of quantum wells through modification of the energy band structure. This makes it an attractive technique for optoelectronic integration. F-implanted IIQWI changes the refractive index in specific locations of the chip, which leads to the formation of optical waveguide gratings. Design, fabrication, and characterization of rib waveguide gratings suitable for Coarse Wavelength Division Multiplexing (CWDM) will be reported. Perturbation analysis along with coupled mode theory for gratings has been used to calculate the reflection coefficient of the gratings. This requires prior calculations of the dielectric constant, which provides the refractive index of the IIQWI MQW layer for different values of operational wavelengths and annealing times, along with the known values for the bulk materials. The design of InGaAsP/InP MQW waveguide gratings have been done and the fabrication steps for achieving the same will be presented. Photoluminescence spectroscopy has been done at the University of Calcutta, to standardize the IIQWI and anneal process. Waveguide gratings for four representative CWDM wavelengths have been obtained. Transmission responses of all four gratings shall be presented. Measured results show - 8-10dB crosstalk among the adjacent channels in confirmation to what has been obtained from the device simulation.

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***Title : New Neuron Models and Their Applications***
***Author(s) : Shiblee Mohammad***
***Roll No : Y5104080***
***Supervisor(s) : Kalra Prem Kumar& Chandra B***

***Abstract***

The neuron model proposed by McCulloch and Pitts has a combination of aggregation and activation functions. The standard form of aggregation function in a Neural Network can be linear weighted sum (Weighted Arithmetic mean of all inputs applied on it) of inputs and the most common activation function are sigmoid or tangent hyperbolic functions. The major issue in the artificial neuron model is the description of the single neuron computation and its interaction with other neurons when used in Neural Network. This thesis attempts to remodel the single neuron computation in the ANN. The main contribution of this thesis can be viewed as six fold. The first prominent contribution is the use of new generalized error measures in the learning of MLP using Back-propagation. In the Back-propagation algorithm, training of the neuron model is done by minimizing the error between target value and observed value. It has been observed that Least Mean Square Error (LMSE) is the most commonly used error measures in the training of Neural Network for real life applications. Using LMSE is appropriate when distribution data is Gaussian. Often in real life situations, data does not follow Gaussian distribution, and the distribution of data is unknown. Since the distribution of data is unknown, using LMSE for training of MLP in Back-propagation algorithm may not give the best performances. It will be reasonable to use some other new error measure to improve the performance of the ANN. In this thesis, new generalized error measures based on different means has been used in Back-propagation algorithm. The weight update equations have been evaluated for each of the error measures. It has been shown on various benchmark time series prediction problems that generalized error measure gives much better performance in comparison to LMSE. The second significant contribution is the development of Geometric Mean based Neuron model. After getting inspiration with the performance of new error measures which are based on different means, a weighted geometric mean based neuron model has been proposed. It is well known that the performance of the neural network depends on the type of aggregation function used in the structure of neuron model. An aggregation function having higher order statistics can produce superior neural network with comparatively lesser number of neurons. Geometric Mean based Neuron (GMN) model is based on a polynomial architecture. The aggregation function of GMN model is based on weighted geometric mean of all inputs. Mathematical structure of this neuron model produces multiplicative function by summing operation. Nonlinearities in the geometric mean based neuron model are depicted with the parameters being multiplied together. The order of hyperplane in geometric mean based neuron (GMN) model is higher than that of MLP, thus the GMN captures nonlinearity more efficiently. The GMN model which forms parabola as basis function improves the convergence speed to a large extent using the same number of neurons and connections. It has been theoretically proved that the GMN model has the approximation capability. Back-propagation with steepest gradient descent and resilient back-propagation algorithm is used for training the Neural Network. Some statistical parameters, such as, Akaike information criterion (AIC), Chi-square test and correlation between the target and observed outputs, have also been reported for proving the superiority of the proposed model. As a third substantial contribution, a novel approach has been proposed for fault diagnosis of internal combustion engine using wavelet energy features and geometric mean neuron model based neural network. Live signals from engine were collected with and without faults by using four industrial microphones. The acoustic signals measured from the large number of faulty engines were decomposed using wavelet transform and energy of each wavelet decomposed signal has been computed and used as a feature vector for further classification using geometric mean neuron model based neural network. Experimental investigations have been carried out to evaluate the proposed technique for online fault diagnosis of single cylinder four stroke IC engine at one of the leading automobile two-wheeler manufacturing company in

India. Analyzed results show that the proposed technique is effective for online fault diagnosis. It can be inferred that the proposed model using Wavelet and GMN would become an appealing tool in non-stationary vibration analysis for diagnosis of localized faults of other mechanical systems. The fourth prominent contribution is the development of new Generalized Harmonic Mean Neuron (GHMN) model by using a polynomial architecture (generalized harmonic mean) as an aggregation function. Resulting neural network with new neuron model has fewer parameters than higher order neural network and it is much easier to train. Generalized Harmonic Mean Neuron model (GHMN) has demonstrated improved computational power and generalization ability. The order of hyperplane in GHMN model is higher than that of conventional model. Other neuron models like McCulloch-Pitts and multiplicative neuron model are special cases of this model. Training of the neural network using GHMN model is accomplished using Back-propagation algorithm. Initial weights of the connections between neurons are tuned by genetic algorithm and later gradient descent back-propagation algorithm is used for updation of weights. It has been theoretically proved that the GHMN model has the approximation capability. Their learning and generalization capabilities have been tested and compared with the existing MLP model with the help of various benchmark problems of classification and function approximations. Comparative performance evaluation on various real life data sets pertaining to time series prediction, function approximation and classification problems reveal that the GHMN model performs far superior compared to the multilayer perceptron (MLP). The fifth substantial contribution can be viewed as Blind source separation using Generalized Harmonic Mean Neuron model. Blind source separation (BSS) is one of the hottest and emerging areas for research in signal processing with solid theoretical foundations and many potential applications such as speech recognition, telecommunication, biomedical engineering, data mining, biometric and medical imaging, etc. Several statistical and Neural Network approaches have been proposed for the solution of Blind source separation. In this thesis, Blind source separation using Generalized Harmonic Mean Neuron model have been proposed. Information-maximization has been used as the learning algorithm. Comparative performance evaluations of this proposed GHMN model has been done on artificial and real life mixture of Blind source separation. (Artificial real life mixture of finger prints, mixture of artificially generated signals). It depicts that separation of original sources in the blind source mixtures is far superior as compared to conventional neuron model. As the last contribution, a novel neuron model termed as Generalized Power Mean Neuron (GPMN) model has been proposed. In this model, the aggregation function is based on generalized power mean of inputs. Computational power of GPMN model has been illustrated on several classification datasets of UCI machine learning repository datasets. The complexity of the proposed Generalized Power Mean Neuron model is higher as compared to Generalized Harmonic Mean Neuron model. Learning of GPMN model is done using genetic algorithm. Other neuron models like McCulloch-Pitts, Geometric Mean Neuron model, Multiplicative Neuron model and Generalized Harmonic Mean Neuron model are special cases of this model.

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