

## M.TECH. THESIS ABSTRACTS 2004

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*Title* : *Controlling An Inertial Wheel Pendulum: A Passivity Approach*  
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*Roll No* : *Y210439*  
*Supervisor(s)* : *Behera Laxmidhar*

### *Abstract*

This thesis is concerned with nonlinear control of an Inertia Wheel Pendulum using passivity approach. The Inertia Wheel Pendulum (IWP) model is one of the simplest prototypes for underactuated systems to test varied nonlinear control strategies. IWP system dynamics has two equilibrium points of which the top unstable equilibrium point offers challenge to a control engineer. The control problem is often defined as swing-ing up the inertial wheel from downward bottom stable equilibrium position towards the top unstable equilibrium point where the wheel must stay stable forever. Implementation of a simple state feedback controller shows that the classical linearized controller can stabilize the pendulum at the top unstable equilibrium point if deflection angle  $|\theta| < 0.12$  radian from the equilibrium position. Thus the problem is redefined if there exists a linearized control that can stabilize the pendulum when the deflection angle  $|\theta| < \pi$  radian. It turns out that the control strategy using input-state feedback linearisation can stabilize the pendulum if the initial position of the pendulum  $|\theta| < \pi$  radian. However, the original control problem is still not solved since the pendulum has to be brought from the downward bottom equilibrium position to the range defined by  $|\theta| < \pi$  radian. Thus came the idea of swing up control as proposed by Spong [1]. A passivity based controller is designed where the IWP system is considered of consisting of two subsystems, namely, pendulum subsystem and wheel subsystem. The output variable is identified for each subsystem so that each subsystem remains passive from input to output. A control law is then proposed so that the combined system of pendulum and wheel is also passive. Further analysis shows that this proposed control law can only swing up the pendulum from the downward bottom stable equilibrium position to top unstable equilibrium position. A compensation term is added to take into account of friction during swing up which increases the amplitudes of swing up oscillations. However, the control law fails to stabilize the pendulum at the top unstable equilibrium position due to the fact that the controller brings the trajectory into a homoclinic orbit which intersects both stable and unstable equilibrium points. Thus the balancing controller is introduced to stabilize the linearized system at the top. Another passivity based controller named Interconnection and Damping Assignment passivity based control is revisited. This method represents system dynamics in Hamiltonian formulations instead of usual Euler Lagrangian (EL) formulation. In Hamiltonian model, the system dynamics are parametrized by two matrices, called interconnection matrix and damping matrix. The controller is designed by choosing suitable closed loop interconnection and damping matrices for a system. The approach involves estimation of an extra energy function term  $H_a$  that must be added to open-loop energy function



which makes the system passive; closed loop. The controller is parametrized in terms of partial differential terms involving estimated  $H_a$ . The stability of this controller algorithm has been proved using La Salle's invariance principle. Although this control algorithm can take the pendulum from its downward bottom equilibrium position to upward top equilibrium position at one go in simulation, the real time experiment can not be done using this algorithm. This is because the algorithm demands very high transient torque and speed demand for the inertial wheel which the available mechatronics control kit in the laboratory can not meet with. In essence, many possible theoretical algorithms can not be implemented in real time because of limitations in the hardware set up. It could be ascertained during this work that dual mode controllers are best suitable for real-time implementation. This work ends with a novel proposal of swing up control using pumping of energy concept. Earlier, energy based swing up controllers have been proposed which could work in simulation, but failed during experimentation due to presence of friction. However, the proposed energy based swing up controller in this work works both in simulation and experimentation.

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**Title** : *Desin And Simulation Of Two And Three -Level Power Active Power Filters*  
**Author(s)** : *Tefera Abate*  
**Roll No** : *Y210445*  
**Supervisor(s)** : *Das Shyama Prasad*

### ***Abstract***

The thesis focuses on an alternative method to strengthen the direct survey estimators and towards the use of spatial interaction amongst the small area units in the form of spatial models the proposed model consists of three equations, the first representing the design (sampling) model, the second equation representing the regression model and the third one ,the spatial model. The simple linear mixed model of Fay and Herriot with no spatial autocorrelation and a purely spatial model (without exogenous variables) are two special case of this model among the eight chapter in the thesis. Chapter 2 is the base chapter which introduces the spatial model. Chapter 3 discusses spatial temporal models as a natural extension of the spatial model in a time series module. Chapter 4 has a multivariate extension of the spatial model. Chapter 5 is concerned with a simple unit specific model for improving the small area estimates, under a survey design scheme which attaches different weights to to the sampled units. Chapter 6 discusses spatial autocorrelation and the structure of the spatial weight matrix and gives test statistics to test the significance of the spatial autocorrelation. Chapter 7 discusses briefly the sampling methodology of data collection by NSSO for its various round under study.

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***Title*** : ***Simulation Study Of Static Transfer Switch With Passive And Active Loads***  
***Author(s)*** : ***Dass Purushotam***  
***Roll No*** : ***Y210425***  
***Supervisor(s)*** : ***Ghosh Arindam & Joshi Avinash***

### ***Abstract***

Nowaday the power electronics devices are used to increase the reliability and the quality of power in transmission and distribution system as well. Static Transfer Switch (STS) is a power quality device that is used to protect sensitive load from sag/swell, fault or any interruption in the preferred feeder. In thesis, the basic topology, the operation and control of single and three phase STS system are presented. The operation of STS system is performed in PSCAD/EMTDC package for passive and hybrid load (RL load and induction motor load) for different conditions of the disturbance. The power distribution STS system is supplied through two independent feeders namely preferred feeder and alternate feeder. An STS is mainly used to transfer the power supply to alternate feeder- when a voltage sag/swell, fault occurs in the preferred feeder. It consists of two-thyristor or GTO switches and control logic. The control logic is composed of voltage detection and gating strategy. In thesis, two-voltage detection strategies and function of control logic are presented. As the sensitive load is fully protected by the STS is called a power quality device or quality-enhancing device. Key words Power Quality, Custom Power, Custom Power Park, Static Transfer Switch (STS) and PSCAD/EMTDC Simulation

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*Title* : *Nonlinear system Identification And Control Using Neural Networks*  
*Author(s)* : *Kumar Swagat*  
*Roll No* : *Y210440*  
*Supervisor(s)* : *Behera Laxmidhar*

### *Abstract*

This thesis is concerned with system identification and control of nonlinear systems using neural networks. The work has been carried out keeping two objectives in mind. First, to design training algorithms for neural networks which are simple, efficient and capable of being implemented in the real time. Second, to design viable neural network controllers for nonlinear and underactuated systems. Recurrent neural networks are capable of learning dynamic nonlinear systems where complete information about the states are not available. Memory Neuron Networks, a special class of RNN, has been used for identifying SISO as well as MIMO systems. The weights are adjusted using Back Propagation Through Time (BPTT). To increase the modeling accuracy, two other algorithms namely, Real Time Recurrent Learning (RTRL) and Extended Kalman Filtering (EKF) have been proposed for MNN. Simulation experiments show that RTRL provides best approximation accuracy at the cost of large training time and large training set. EKF gives comparable approximation accuracy with significant reduction in the number of presentations required as compared to RTRL. A novel algorithm based on Lyapunov stability theory has been proposed for weight update in feedforward networks. Interestingly, the proposed algorithm has a parallel with the popular back propagation (BP) algorithm. It is shown that fixed learning rate in BP could be replaced by an adaptive learning rate which is computed using Lyapunov function approach. It is shown that a modification in the Lyapunov function can lead to smooth search in the weight space thereby speeding up the convergence. Through simulation results on various benchmark problems, it is established that the proposed algorithm out-performs both BP and EKF algorithms in terms of convergence speed. Certain system identification issues are also analyzed for this algorithm. Some of the recent and widely known neural network based controllers have been analyzed in detail. Two existing algorithms namely NN based robust backstepping control and singular perturbation technique have been used to control various kinds of robot manipulators including flexible link and flexible joint manipulators. A neural controller based on partial feedback linearization has been proposed for pendubot. The simulation results show a promise that neural networks can be used for this class of underactuated mechanical systems which is yet to be tested through hardware implementations. IV

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*Title* : *Design Aspects Of Current Controlled VSI*  
*Author(s)* : *Milind Dighrasker*  
*Roll No* : *Y210421*  
*Supervisor(s)* : *Sensarma Partha Sarathi*

### *Abstract*

In this thesis, a few design aspects of a three phase current controlled Voltage Source Inverter (VSI) are investigated in detail. The dynamic analysis of the currents during controller saturation of VSI, connected to the Point of Common Coupling (PCC) is presented. Closed-form solutions of the VSI currents are obtained using a piecewise linear, state-space averaged model of the VSI under the linear and saturated regimes of the current controller. Using these results, two new algorithms are proposed which best improve current dynamics during controller saturation, while simultaneously limiting the reference voltage within the modulation range. This ensures that no lower order harmonics are introduced in the VSI currents, resulting in simplification of the ripple filter design. Simulation results obtained are compared with those from existing algorithms. The simulation model includes device switching and uses multi-rate sampling, for the physical plant and controller, to reflect major non-idealities of a practical system. It is shown that the proposed algorithms result in decoupled current control and faster current dynamics. A procedure is proposed, which estimates the saturation dwell of current controlled VSI without detailed simulation. The comparison of execution time taken by a digital computer for the proposed procedure and erstwhile methods of detail simulation is included. This comparison shows that the proposed procedure results in significant reduction of execution time. To improve the closed-loop performance of the system, a high accuracy Hall effect current sensor card is developed. The improvement in performance of current sensor is verified experimentally. A step wise procedure for designing of IGBT gate driver circuit is presented. An example is included to elucidate the design procedure,

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*Title* : *Impact Of Carbon And Energy Tax On Generation Expansion Planning Of Integrated Indian Power System*  
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*Roll No* : *Y210435*  
*Supervisor(s)* : *Srivastava S C*

### *Abstract*

This thesis presents a study carried out on India power sector to analyze the impact of carbon tax and energy tax on generation expansion planning. Economic and environmental implications of carbon as well as energy tax have been analyzed using an Integrated Resource Planning Analysis (IRPA) software as generation expansion planning tool. The studies have been carried out for different levels of carbon/energy tax and price elasticity of demand. It is observed that the imposition of the taxes result in switching of generation from conventional coal plants to gas fired plants, clean coal technologies along with the reduction in electricity demand due to increased average incremental cost. Generation expansion cost increases as a result of increased fuel and variable cost. The carbon tax has been imposed on the fossil fuels depending on their carbon content and the energy tax on the energy sources depending on their energy content. The study reveals the following:- Implication of the carbon and energy taxes has environmental benefits of reducing Green house gases, which causes global climate change.- Imposition of taxes result in higher energy prices that would stimulate the development of energy-efficient technologies and would spur the commercialization of technologies.- The taxes, in addition to reducing GHG emissions, are the additional revenue generation and also reduce the emission of local pollutants such as SO<sub>2</sub> and NO<sub>x</sub>.- Carbon tax leads to reduction in pollutant emissions due to price induced energy conservation and fuel switching, whereas energy tax leads to emissions reduction mainly due to price induced energy conservation.

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***Title*** : ***Analysis And Implementation Of Quasi-Resonant DC-Link Inverter***  
***Author(s)*** : ***Gaurav Sharma***  
***Roll No*** : ***Y210409***  
***Supervisor(s)*** : ***Das Shyama Prasad&Doradla S***

### ***Abstract***

Soft switching is preferred over Hard switching as the latter has various problems. Soft-switched dc-ac inverters are attractive for power supply and motor drive applications due to its distinct advantages such as high efficiency, high frequency operation, compact structure, and low EMI etc. compared to hard-switched converters. The present thesis deals with design, detailed mathematical analysis, simulation and laboratory based implementation of quasi-resonant dc link inverter for low and high power factor loads. A novel QRDCL inverter suitable for high as well as low power factor loads is proposed. The quasi-resonant link comprises of four switches and three resonant components. The inverter operates satisfactorily with positive and negative dc link current. The simulation is carried out with the help of MATLAB incorporating Modified Space Vector Modulation (MSVM) control technique. The experiment is conducted with R-L load. Simulation and experimental results reveal soft-switching with low and high power factor loads. For experimental results a laboratory prototype has been fabricated using Intelligent Power module (IPM) and PC based control. The detailed study of the proposed QRDCL inverter reveals that it can be used not only for power supplies but also to high performance induction motor drives. Because of soft-switching and high frequency performance of the inverter, it can find application in airborne power supplies where size and weight due to paucity of space are of paramount importance. Key words: Dc-Ac converters (Inverters), Quasi-Resonant DC link (QRDCL) inverter, High and low power factor loads, Modified space vector modulation (MSVM).

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*Title* : *Nonlinear Control Strategies For Underactuated Mechanical Systems*  
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*Roll No* : *Y210405*  
*Supervisor(s)* : *Behera Laxmidhar*

### *Abstract*

This thesis is concerned with nonlinear control strategies for underactuated mechanical systems. Two specific underactuated systems - (i) Planar Vertical Take-Off and Landing (PVTOL) aircraft and (ii) Reaction wheel pendulum - have been considered. Underactuated mechanical systems are those with lesser number of actuators than the number of configuration variables. There has been a lot of work in the past few years in this area due to its wide scope of applications in fields like robotics, space and underwater vehicles. The control problem of PVTOL aircraft has been revisited. It is observed that direct application of Input-Output linearization and ordinary Backstepping. This is because the PV. techniques do not stabilize the PVTOL aircraft system. PVTOL aircraft is simultaneously an underactuated system as well as a nonminimum phase system. Three existing control strategies for PVTOL aircraft, namely, (i) Decoupling Method (ii) Forwarding Method (iii) Linearization Method have been investigated in this thesis and the comparison of performances has been done. In contrast, Reaction Wheel Pendulum, another example of underactuated system is very difficult to control using a single control algorithm. The normal approach has been to employ dual mode control that consists of swing up and balancing control. At first, we have investigated four different control algorithms based on linearization to stabilize the Reaction Wheel Pendulum at the top unstable equilibrium point. Specifically two control schemes, namely, (i) linearization of transformed model and (ii) fuzzy logic controller are novel applications in the context of Reaction Wheel Pendulum. The control problem of reaction wheel pendulum is made complete when swing up controller is preceded by the above balancing control. The swing up controller brings the pendulum close to top unstable equilibrium point from where the balancing controller takes over. Two novel swing up control schemes have been proposed in this thesis. The first one is based on the fact that instability results in increase in the system energy. The second one is based on simple backstepping approach. Finally, both the forms of controllers have been clubbed to observe the combined performance of dual mode controllers to stabilize the Reaction Wheel Pendulum at the top unstable equilibrium position starting from the rest stable equilibrium point. The proposed controllers have been implemented in real-time on a Quanser mechatronics control kit. Experimental results are quite satisfactory. A surprising result is that a simple swing up technique based on backstepping could bring the pendulum from downward rest position to upward unstable equilibrium point in a minimum time.

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**Title** : *Analysis, Simulation And Microcontroller Based Implementation Of Boost Type Switch Mode Rectifier*  
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**Roll No** : *Y210444*  
**Supervisor(s)** : *Das Shyama Prasad*

### ***Abstract***

AC-DC conversion is used in electronic equipment requiring DC power, where an AC power supply is available. Conventional uncontrolled and phase-controlled converters, though simple and inexpensive, have non-sinusoidal current input and poor power factor. As a result, the utility is polluted with harmonic currents which lead to voltage distortion at the point of common coupling. This voltage distortion affects other frequency sensitive equipments connected to the utility. Poor power factor results in higher line voltage drop and increased losses. The conventional way of tackling this problem is to use passive filters, which are unattractive due to increased volume and weight, low efficiency and limited (fixed) bandwidth. Switch mode rectifiers (SMR) offer an attractive solution to harmonics and poor power factor problem with ac-dc conversion. A boost type SMR can be operated in continuous current mode (CCM) or in discontinuous current mode (DCM). The input current of SMR is sinusoidal with nearly unity power factor as per IEEE or IEC standard. In this thesis, a detailed analysis of the SMR operating in various modes has been made. The mixed mode SMR is operated under purely CCM at higher load and purely DCM at light load condition at constant but two different switching frequencies. Thus, the dual mode of operation is avoided where the input current distortion is the maximum. All these control schemes are simulated using MATLAB and the results are presented. A low cost microcontroller based implementation of a fixed frequency SMR has been made in the laboratory. The results from the experimental setup are compared with corresponding simulation results and they show close agreement. Key words: Harmonic standards, constant frequency operation, continuous current mode (CCM), discontinuous current mode (DCM), mixed mode, microcontroller based implementation.

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**Title** : *Series And Shunt Compensators For Transmission System Using H-Bridge Cascade Connected Inverter*  
**Author(s)** : *Rajnish Gaur*  
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**Supervisor(s)** : *Ghosh Arindam & Joshi Avinash*

### ***Abstract***

In this thesis, Static Synchronous Series Compensator (SSSC) and Static Synchronous Compensator (STATCOM) have been designed using cascade inverters. Basic concepts of series and shunt compensation have been discussed. The feasibility of SSSC as a series compensator and that of STATCOM as shunt compensator has been explained. It has been verified from simulation study that SSSC can be used to improve power flow across the transmission line and hence to improve the transient stability. In the same way STATCOM can be used to keep the mid point voltage equal to the desired value. This breaks the transmission line into two parts which increases the power transfer limit, transient limit and voltage stability of the transmission system as well. The greater number of shunt compensators, the less variation in voltage along the line. Basic concepts of cascade inverter have been discussed. The cascade system consists of six H-bridge modules per phase which generate 6 pulses for each half cycle of power frequency. The 13 level inverter has been simulated. Two configuration schemes of cascade inverter have been discussed. The first does not need a transformer at all and the other configuration needs isolating transformers. Both the configurations have been used separately to implement SSSC and STATCOM. Their relative merits and demerits have also been explained. A method for controlling cascade inverter has been used which ensures that the capacitor voltages are regulated using the charging and discharging of capacitors. This is possible because by changing the phase difference between line current and inverter output voltage from  $90^\circ$  we can either charge the capacitor or discharge it. The modulation scheme ensures that output voltage produced by cascaded inverter has low harmonic content. Indirect control approach has been used for regulating the inverter parameters in accordance with varying system requirements. The indirect control regulates the dc capacitor voltages with respect to a reference value. The reference value varies with the change in functional requirements of SSSC and STATCOM. It has been verified from simulation results that it is less efficient and slow control, as the dc capacitor takes significant time to charge or discharge to a new reference value for the new functional requirement. The proposed system has flexibility in expanding the operation voltage by increasing the number of H-bridge modules. This simulation study has been done using PSCAD/EMTDC package version 3.

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*Title* : *Application Of Three-Phase Four-Wire Active Filter For Shunt And Series Compensation In Systems With Non-Ideal Supply*  
*Author(s)* : *Shivkumar Venkatraman Iyer*  
*Roll No* : *Y210414*  
*Supervisor(s)* : *Ghosh Arindam & Joshi Avinash*

### *Abstract*

The dramatic rise of power electronic converters, rectifiers and cycloconverters besides an increased incidence of unbalanced loads has resulted in distortion and unbalance in the currents drawn from the supply and in the voltages at the Point of Common Coupling (PCC). The high harmonic content of the current in the system could cause overheating in transformers and other electric machines. Unbalance in loads as well as widespread use of single-phase converters will result in high current in the neutral. As the distortions in the PCC voltage would affect all the loads connected at the PCC, there arises a need to filter out the harmonics drawn by the non-linear load and further provide some power factor correction at the PCC. For improved harmonic filtering, power factor correction and voltage regulation active filters are replacing the older passive filters. Shunt active filters have been studied and simulated in this thesis for the purpose of harmonic filtering, power factor correction and voltage regulation at the PCC. Existing algorithms used for generating references for injected currents have been reviewed and a new algorithm has been proposed to overcome their drawbacks. Inverter topologies used to realize the shunt active filters have been compared as well as filter structures for bypassing high frequency components and control strategies have been discussed and implemented. Simulation studies have considered all possible disturbances in the supply and the source and the performance of the shunt active filter have been studied. For the purpose of load voltage regulation series active filters have also been discussed. As with shunt active filters, a comparison of inverter topologies and filter structures has been done for the series active filter as well. To regulate the load voltage against deep sags in the source voltage auxiliary supply of power to the DC link through a rectifier has been simulated and the results will show that the load voltage has been completely regulated despite the poor quality of the source voltages.

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*Title* : *Simulation Of Boost Rectifier As An Active Power Filter*  
*Author(s)* : *Ganesan R*  
*Roll No* : *Y210408*  
*Supervisor(s)* : *Joshi Avinash*

### *Abstract*

A planar simulation of film boiling and bubble formation in water at 373°C, 219 bar on an isothermal horizontal surface was performed by using a volume of fluid (VOF) based interface tracking method. The complete Navier-Stokes equations and thermal energy equations were solved in conjunction with a interface mass transfer model. The numerical method takes into account the effect of temperature on the transportive thermal properties (thermal conductivity and specific heat) of vapor, effects of surface tension, the interface mass transfer and the corresponding latent heat. The computations provided a good insight into film boiling yielding quantitative information on unsteady periodic bubble release patterns and on the spatially and temporally varying film thickness. The computations also predicted the transport coefficients on the horizontal surface, which were greatly influenced by the variations in fluid properties, compared to calculations with constant properties.

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*Title* : *Studies On resonance behaviour Of Dielectric Resonator In MIC Environment Using Finite Difference Time Domain Technique And Efficient Prony's Algorithm*  
*Author(s)* : *Kumar Vaibhav Srivastava*  
*Roll No* : *Y210417*  
*Supervisor(s)* : *Biswas Animesh*

### *Abstract*

The role of dielectric resonator in miniaturization of microwave filters and oscillator is well recognized. In this thesis the resonance behaviour of dielectric resonator in MIC environment has been presented in detail. For the calculation of resonant frequency of DR, the Finite-Difference Time-Domain technique has been used with the Fast Fourier Transform. The two-dimensional FD-TD is used for the  $c|>$ -independent modes. For the hybrid modes and  $\wedge$ -dependent modes, three-dimensional FD-TD has been implemented. In the three-dimensional FD-TD program the dielectric loss, substrate loss and conductor loss are included such that we can calculate the Q-factor also using FD-TD. For the resonant frequency calculation the FFT has been used, which takes large number of time samples to get the accurate solution. To reduce the time sample one efficient called Prony's method is introduced here. In Prony's method we need very less sample as compared to FFT and it can also use for the calculation of Q-factor. As in Prony's method, the computation time is very less; we can have fine mesh size. In this thesis a novel dielectric resonator structure has also been suggested which gives the improved mode separation on ring DR in MIC environment. The resonant frequency depends upon the field pattern of that mode and the field pattern can be affected by the change of permittivity of the region. Therefore, to influence the spurious mode, we can change the permittivity of the region where the electric fields of spurious modes are confined. Here the interested mode is TE<sub>0is</sub> and spurious modes are TM<sub>0ia</sub>, HE<sub>115</sub> and HE<sub>i25</sub>.

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*Title* : *Analysis And Design Of On-Chip Spiral Inductors And TransFormers For GaAs rf intEGrated Circuits*  
*Author(s)* : *Akhilesh Mohan*  
*Roll No* : *Y210401*  
*Supervisor(s)* : *Biswas Animesh*

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*Title* : *Coax Resonator Filters- A Study*  
*Author(s)* : *Sahaya Kulandai Raj J*  
*Roll No* : *Y210434*  
*Supervisor(s)* : *Harish A R*

### *Abstract*

A new technique to compute the coupling between non-identical resonators numerically has been proposed in this work. In this technique, the coupled resonators are separated into two individual structures by introducing electric and magnetic wall boundary conditions at the plane obtained after separation. Finite element method is used to compute the eigen-frequencies of the structures that are in-turn used in the coupling computation. The proposed technique has been applied to compute the coupling between combine resonators. It is found to be computationally much faster than the iterative technique. In the iterative technique, the difference between eigen-frequencies due to the entire structure is brought to minimum by adjusting the electrical parameters of the resonators. Under this condition, the two cavities are synchronously tuned. The coupling coefficient is computed from the ratio of difference in the eigen-frequencies to the resonant frequency. Another method for visualizing the effects of dispersion of coupling coefficients is presented. This method is not case specific. This also helps to compare the performance of various coupling elements and to see movement of transmission zeros due to dispersion. The N+2 synthesis, which assumes that the source and load are connected, is studied and presented with examples. The similarity transformation to annihilate the //awkward-to-realize,/ couplings is discussed. The realization of bandpass combine filters is also discussed with an example. A good account of Generalized Chebychev polynomial responses is given with number of examples. An optimisation procedure to find the order of the transfer functions and the location of transmission zeros is also presented. RoU No. Y210434 Electrical Engineering

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*Title* : *Studies On The Performance Of Outdoor Optical Wireless Systems Under Diffrent Atmospheric Conditions*  
*Author(s)* : *Manoj Satle*  
*Roll No* : *Y210420*  
*Supervisor(s)* : *John Joseph*

### *Abstract*

An optical wireless system is an alternate wireless system for high speed data transfer to combat the highly congested RF spectrum. Outdoor optical wireless systems are becoming more popular and gaining market acceptance as a functional wireless tool, because of their advantages such as, unlimited and unregulated spectrum, low cost, etc. One barrier which still exists in the acceptance for wide acceptance of owe systems is the effect of weather on such systems. The performance of these systems are very much affected by the atmospheric attenuation due to non-stationary weather conditions viz. fog, haze, rain, etc. Of particular interest is the effect of fog as it causes absorption and scattering losses thereby giving higher optical power attenuation. In this work a comprehensive review of the outdoor optical links is done and their major features compared. Atmospheric attenuation is theoretically calculated using present models and is compared with experimental results under different fog conditions. An experimental outdoor optical link with 10Mbps data rate and length up to 60m is designed, implemented and tested. The transmitter uses a low cost laser diode and a TTL driver IC. The receiver uses BPX65 PIN photodiode with a JFET frontend preamplifier. Receiver uses a focusing lens to focus the laser light on the detector aperture.

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*Title* : *Turbo Codes For Wireless Systems With Imperfect Channel Estimates*  
*Author(s)* : *Mukherjee Asim*  
*Roll No* : *Y210404*  
*Supervisor(s)* : *Vasudevan Kasturi*

### *Abstract*

Turbo codes are family of forward error correcting codes, whose performance is near to Shannon limit. Turbodecoding in this thesis is based on the Maximum a posteriori (MAP) algorithm. Here a new metric for turbodecoding on Rayleigh fading channels with noisy channelestimates is used in additive white Gaussian noise(AWGN). By including the error variance of the channelestimate in the decoder metric derivation, the correctchannel reliability factor (Lc) is calculated. We considered it in AWGN by estimating the channel. The improvement in performance by using the new decoding metric is demonstrated through simulations. Simulations show that the signal-to-noise ratio gain of using this new metric, is appreciable. The gain is obtained without any complexity increase.

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*Title* : *New Framework For Constructing ZCZ And Related Sequences*  
*Author(s)* : *Appuswamy Rathinakumar*  
*Roll No* : *Y210429*  
*Supervisor(s)* : *Chaturvedi Ajit Kumar*

### *Abstract*

Rathinakumar, Appuswamy (M.Tech, Information Systems) A New Framework for Constructing ZCZ and Related Sequences Thesis supervised by Dr. A. K. Chaturvedi We propose a new framework for constructing Zero Correlation Zone (ZCZ) sequences from mutually orthogonal Golay complementary sets. We present several characterizations which make it possible to design ZCZ sequences of new lengths and new Interference Free Window (IFW) lengths. It has been shown that the recursive construction of mutually orthogonal Golay complementary sequences is inherent in the above framework. Previously known constructions are shown to be special cases of this characterization. Notion of mutually orthogonal ZCZ sequence sets is introduced. Using the framework developed, it has been possible to construct multiple mutually orthogonal ZCZ sequence sets for a given Interference Free Window (IFW). Problem of direct construction of mutually orthogonal Golay complementary sequences from Reed Muller codes is addressed. We compare the spectral efficiency of CDMA systems employing mutually orthogonal sequence sets with that of Large Area Synchronous CDMA systems and orthogonal CDMA systems. The characterizations developed have been used to construct ZCZ sets whose subsets constitute ZCZ sequences with larger IFW. We discuss the need to obtain new bounds which can apply non-uniform correlation windows Possible approaches to obtain relations between different parameters of interest have been discussed.

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*Title* : *A Fast Code Acquisition Algorithm For WCDMA Uplink*  
*Author(s)* : *Banerjee Snehamoy*  
*Roll No* : *Y210432*  
*Supervisor(s)* : *Chaturvedi Ajit Kumar*

### *Abstract*

Thesis Title: "A fast code acquisition algorithm for WCDMA uplink" Name of thesis supervisor: Dr Ajit Kumar Chaturvedi Month and year of thesis submission: August 2004 The existing 256 chips long complex scrambling code in WCDMA for high data rate users is not suitable for delay sensitive applications. A new fast code acquisition algorithm for WCDMA uplink is proposed. The complex part of the user specific short scrambling code is concatenated with length 13 binary Barker sequence at the 1st and 129th chip. A Barker Code Match Filter is used at the Base Station for joint detection of multipath signals of different Mobile Stations using Constant False Alarm Rate detection. For user specific code acquisition, a parallel search by Breadth-First Tree Search method using Truncated Sequential Probability Ratio test is used. The results obtained by simulation indicate that the mean acquisition time is much less than the full length searches.

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*Title* : *Turbo Codes For FH-SS Communication System In Partial Band jamming Environment*  
*Author(s)* : *Patel Gopal*  
*Roll No* : *Y210411*  
*Supervisor(s)* : *Vasudevan Kasturi*

### *Abstract*

Turbo codes are investigated in a Slow Frequency Hopped Spread Spectrum (SFH-SS) system, with partial band jamming. The channel model is that, of a partial-band jammer in which a fraction of the frequency band is jammed and the remaining fraction is unjammed. We focused on the implementation and performance of a modified turbo decoder for this model. Presence of partial band jammer makes channel in jammed and unjammed state. Knowledge of the channel state for each received symbol is known as side information (SI.) We considered both cases of known and unknown channel state for multiple number of bits per hop. Our approach is to modify the calculation of branch transition probabilities in the original turbo decoder. For the cases with no side information (NSI) and multiple bits per hop, we iteratively calculated the channel state estimates. The performance of turbo codes is compared for coherent and non coherent detection in SI and NSI case.

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*Title* : *Turbo Decoding In ISI Channel*  
*Author(s)* : *Soni Sanjay Kumar*  
*Roll No* : *Y210436*  
*Supervisor(s)* : *Vasudevan Kasturi*

*Abstract*

Turbo codes are a family of forward error correcting codes, whose performance is near Shannon limit. Turbo Decoding is based on the Maximum a posteriori algorithm (MAP) algorithm. In this thesis, the problem of turbo decoding in ISI channel is studied. A super-trellis structure method has been presented and modified turbo decoding is suggested. The improvement in performance by using super-trellis method is demonstrated through simulations.

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*Title* : *Super-Resolution Of Color Video Using Two Dimensional Representation Of Colour*  
*Author(s)* : *Pankaj Kumar Bajpai*  
*Roll No* : *Y210422*  
*Supervisor(s)* : *Gupta Sumana*

### *Abstract*

Recent years have seen growing interest in the problem of super-resolution restoration of color video sequences. The traditional single image restoration problem uses only a single input image for processing. However, reconstructing super-resolution images from multiple undersampled and degraded images can take advantage of the additional spatio-temporal data available in the image sequence. In particular, camera and scene motion lead to frames in the source video sequence containing similar, but not identical information. The additional information available in these frames make possible reconstruction of visually superior frames at higher resolution than that of the original data. However, super-resolution techniques proposed so far use 3D representation of color. In this thesis, we propose a new method for super-resolution enhancement of color video using 2D representation of color. This representation reduces the computation time involved in super-resolution significantly. A method of mapping of color from three dimensional space to two dimensional space is discussed. Experimental results obtained prove that execution time is significantly reduced using the proposed 2D representation of color with quality of enhanced images comparable to the 3D case.

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*Title* : *Biomathematical Modeling And Intervention In The Human Male HPG Axis*  
*Author(s)* : *Kumar Shailesh*  
*Roll No* : *Y210433*  
*Supervisor(s)* : *Venkatesh K S*

### *Abstract*

A model of the human male Hypothalamus-Pituitary-Gonadotropin (HPG) Axis is used to study the hormone levels of Gonadotropin Releasing Hormone (GnRH), Luteinizing Hormone (LH) and Testosterone (Te), their concentration and secretion over time. A stochastic point process responsible for generating episodic release of GnRH, that is modulated negatively by short-loop (control system). The various reported interactions in the HPG axis are modeled in a simulator we develop using a combination of moving average filters, nonlinear transformations, pulse shaping function, etc. Starting with the small amount of empirically generated data reported in the literature, we generate, using the simulator, synthetic data for 30 days, that is designed to match close the statistical properties of the empirical data. The simulator is thus capable of running many week-long simulations of the functioning of the HPG axis, under autonomous operation. Finally, we intervene in the operation by introducing extrinsic Testosterone using a Testosterone Transdermal Delivery Device (T-TDD) for 20 days and observe the consequences. We conclude that increasing the dose level of T-TDD and/or the frequency of application lead to a longer time to recovery of the system to the original GnRH and Te levels. Higher T-TDD dose levels and more frequent dose repetition play a significant role in the determination of the recovery time.

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*Title* : *Transmitter Precoding For Space-Time CDMA System In Multiuser Environment*  
*Author(s)* : *Yadav Prabhakar*  
*Roll No* : *Y210424*  
*Supervisor(s)* : *Vasudevan Kasturi*

### *Abstract*

A code division multiple access (CDMA) system has an inherent problem of multiple access interference (MAI) and co-channel interference while fading is a big problem of any communication system. A way to solve the problem of fading was given by Alamouti by introducing the concept of multiple antenna system where diversity is achieved using multiple antennas at the base station as well as at the mobile station. In this thesis, we have combined together both the space-time block coded and DS-SS-CDMA system and then carried out precoding to reduce the problem of multiple access interference. By using multiple antenna system, we have achieved diversity. Precoding at transmitter end represents a linear transformation of the transmitted signals, such that the mean squared errors at  $N$  receivers are minimized. This process of precoding shifts the computational complexity from mobile station to the common transmitter, where it is less critical, thereby reducing the size, power consumption and cost of the mobile station. In this work, we have first designed a multiple user space time block coded DS-SS-CDMA system in a fading environment. Then we have designed transformation filter for the transmitter end and compared the system when precoding or linear transformation has been done in single antenna system. VI

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*Title* : *Image Compression Using Wavelet Footprints*  
*Author(s)* : *Behera Tushar Ranjan*  
*Roll No* : *Y210443*  
*Supervisor(s)* : *Sharma Govind*

### *Abstract*

Wavelets are widely used to represent smooth signals because of their ability to produce a sparse representation of the signal. A sparser representation is possible as wavelet coefficients are correlated across the scale. Wavelet footprints are used to exploit the redundancy of the wavelet coefficients and hence to generate a sparser representation of the signal. A couple of algorithms are proposed to generate a parsimonious representation of the signal using footprints. The comparison with standard algorithms like matching pursuit suggests better performance of the proposed algorithms. The application of wavelet footprints in image compression problems is also explored. A novel way to cluster the footprint coefficients and to code them using a modified differential encoder is proposed. The analysis of the algorithms is carried out for synthetic as well as natural images. It is found that the footprint-based algorithms outperform the wavelet-based algorithm for smooth images and the performance is comparable for natural images.

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*Title* : *Improved Bpsk Space -Time Turbo Codes*  
*Author(s)* : *Singh Jawahar*  
*Roll No* : *Y210412*  
*Supervisor(s)* : *Vasudevan Kasturi*

### *Abstract*

Combination of space-time coding and the turbo coding is called space-time turbocodes. The space-time turbo codes benefit from both the spatial diversity gain of space-time code and the powerful coding gain of turbo codes, thus provide robust errorcorrecting performance over the time varying channels. In this thesis we proposed super trellis approach to decode the binary phase shift keying (BPSK) space-time turbocode. It is shown that the proposed decoding scheme have a signal-to-noise ratio (SNR) gain of 0.5 dB at bit error rate (BER) of  $10^{-3}$  over the space time turbo codes with the iterative non-binary maximum a posteriori (MAP) decoding, proposed by H.Su. and Geraniotis [12], in a quasi-static fading channel.

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*Title* : *Compressed Video Indexing And Retrieval System Using Two Dimensional Representation Of Color*  
*Author(s)* : *Prasad M Anjaneya*  
*Roll No* : *Y210419*  
*Supervisor(s)* : *Gupta Sumana*

### *Abstract*

IVAbstractOne of the challenging problems in creating multimedia database is the organization of the visual information. Since video requires large amounts of storage and processing, efficient indexing and retrieval of video has become a necessity. Content based video indexing and retrieval systems use visual features like color. Color based video indexing and retrieval methods proposed so far use 3D representation of color. In this thesis, we propose a new method for indexing and retrieval of video using 2D representation of color. This representation reduces the retrieval time significantly. A method of mapping of color from three dimensional space to two dimensional space is discussed. Video indexing tools developed support automatic segmentation of video, identification of keyframes, keyframe clustering and extraction of visual features. These visual features are used for efficient video retrieval. The proposed video indexing method uses DC frames of M P E G compressed bit streams. Abrupt scene changes as well as special editing effects such as dissolves and fades are detected accurately. A new method for keyframe clustering is proposed which reduces the redundancies in the keyframes. Color layout descriptor is used to extract the indices of the keyframes and to retrieve the video segments efficiently. Experimental results obtained prove that retrieval time is significantly reduced using the proposed 2D representation of color.

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*Title* : *Multiple Antenna Systems Using OFDM Technique (MIMO - OFDM) For Wireless Lan*  
*Author(s)* : *Hrishikesh Venkataraman*  
*Roll No* : *Y210413*  
*Supervisor(s)* : *SinhaVishwanath*

### *Abstract*

wireless communication system wherein multiple antennas are employed at both the transmitter and receiver (multiple input multiple output - MIMO antenna systems) is considered. In a rich scattering environment like wireless local area network, the correlation among different spatial subchannels is low which makes it possible to efficiently utilize the channel capacity by transmitting independent data streams across parallel subchannels. However, in case of a broadband wireless channel, the signal undergoes frequency selective fading which not only increases the complexity of the receiver but also affects the capacity of the MIMO system. Orthogonal Frequency Division Multiplexing (OFDM) is a promising technique for achieving high data rate and combating multipath frequency selective fading in broadband wireless communications. A combination of MIMO - OFDM would offer increased data rate and lower implementation complexity in a system with large bandwidth-delay product. In this thesis, some of the different detection algorithms that could be employed at the receiver are investigated and their performance evaluated. A novel detection method, the QR decomposition of the channel matrix based on Gram-Schmidt procedure has been proposed along with its variant, the sorted QR method for the MIMO-OFDM scheme. A post sorting algorithm (PSA) based on MMSE extension of the sorted QR method in cases where the sorted QR method does not lead to an ascendingly-ordered diagonal elements of the upper triangular matrix R obtained through QR decomposition of the channel matrix H. The DSP implementations of the receiver oriented

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*Title* : *3D Video Coding Based On Mixed Transform Techniques*  
*Author(s)* : *Ravi Kishore Paruchuru*  
*Roll No* : *Y210430*  
*Supervisor(s)* : *Gupta Sumana*

### *Abstract*

The thesis work is primarily concerned with the design of a "Complete" codec operating at low bit-rate (0.01-0.05 bpp). By "Complete" we mean it should possess advanced features of Scalability (spatial, SNR and Temporal) as well as Effective Packetization. The proposed codec uses both DCT and DWT in order to exploit adopted in view of the Mixed transforms performing better than single transform methods which are generally suitable for a particular subset of videos. A new Spatio-temporal tree structure has been devised for the unique frame structure that this proposed coder provides. Motion Compensation is not used in the coder. Comparisons of the proposed coder have been made with the existing codec that uses 3D-wavelet and 3D-SPIRT. Satisfactory results are obtained for low motion videos. To incorporate the features of Spatial 3D SNR scalability a layered bit-stream has been generated with multiresolution encoding, The packetisation of the video was done using Packetized zero tree wavelet coding algorithm. The Packetized video from the proposed coder is tested for two types of errors Random and Burst Packet errors. The results obtained indicate the robustness of the proposed coder against both Random and Burst packet losses as well as a graceful degradation of PSNR with increasing, packet losses,

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*Title* : *Image Enhancement In 2-D And 3-D Using Curve Indicator  
Random Field*  
*Author(s)* : *Kaustav Nandy*  
*Roll No* : *Y210415*  
*Supervisor(s)* : *Sharma Govind*

### *Abstract*

In this work contour and image enhancement has been viewed as a statistical estimation problem both in 2-D and 3-D. In particular, the classical Gestalt perceptual organization cues of proximity and good continuation, the basis of many current curve enhancement systems, can be statistically measured in images. For the estimation purpose the Curve Indicator Random Field (CIRF) acts as a prior. Technically, this random field is a superposition of local times of Markov processes that model the individual curves; intuitively, it is an idealized artist's sketch, where the value of the field is the amount of ink deposited by the artist's pen. More fundamentally, the CIRF is a model of an ideal edge/line map, and therefore provides a basis for rigorously understanding real (noisy, blurry) edge/line measurements as an observation of the CIRF. This model therefore allows the derivation of filters for enhancing contour structure in noisy images. The minimum mean squared error filter has been derived for the enhancement purpose. Example computations in 2-dimensions and 3-dimensions illustrate that the procedure is successful in noise cleaning and contour enhancement to a very good extent.

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***Title*** : *Fitting And Tracking In 2-D And 3-D Images Using Wavelet Based Deformation Model*  
***Author(s)*** : *Biswas Soma*  
***Roll No*** : *Y210438*  
***Supervisor(s)*** : *Sharma Govind*

### ***Abstract***

This work concentrates on fitting and tracking of 2-D and 3-D images using a deformation model. The deformation model uses wavelets and also utilizes the interrelation between wavelets and function spaces (in this case Sobolev space) in order to impart a certain degree of smoothness to the fitted curves. The formulation defines a probabilistic model that induces a prior distribution for contour deformation. To increase the robustness of the approach, the wavelet models are expressed in terms of shape spaces. Based on this distribution, the fitting problem is solved in Bayesian terms. Several examples illustrating the success of the model in both 2-D and 3-D have been included. Also the same framework has been used for the tracking purpose. The deformation model is used to generate a prior dynamic model for contour evolution in time. This probabilistic model is then applied to solve the tracking problem. The tracking problems for both the 2-D and the 3-D cases have been solved using the Kalman filter.

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*Title* : *Texture Retrieval Using Angular Wavelet Frames*  
*Author(s)* : *Kumar Dinesh V*  
*Roll No* : *Y210407*  
*Supervisor(s)* : *Gupta Sumana*

### *Abstract*

In this thesis, we primarily focus on the use of texture information for image retrieval. We describe two different methods of texture retrieval by combining the two related tasks, namely feature extraction (FE) and similarity measurement (SM), within a statistical framework. In the first method we applied angular wavelet frames (AWF) to the textured image. The 2D AWF is constructed by applying frequency transformations to the prototype filters of a 1D perfect reconstruction filter bank (PRFB) to obtain 2D filters. The objective of using AWF is to improve the performance of existing wavelet based methods for textures having long-range and non-linear spatial correlation. The statistical scheme leads to a new angular wavelet-based texture retrieval method that is based on the accurate modeling of the marginal distribution of angular wavelet coefficients using generalized Gaussian density (GGD) and on the existence of a closed form for the Kullback - Leibler distance (KLD) between GGDs. Experimental results on a database of 640 texture images indicate that the new method significantly improved the retrieval rates, e.g., from 75% to 88%, compared to the wavelet approach. In the second approach a statistical model (AR model), consisting of random fields in angular wavelet sub bands, is used to represent texture. The statistical scheme leads to a new angular wavelet-based texture retrieval method that is based on the modeling of the spectral distribution of angular wavelet coefficients using AR model and on the existence of a closed form for the Kullback-Leibler distance (KLD) between AR-models. Experimental results on a database of 640 texture images indicate that the new method significantly improved the retrieval rates, e.g., from 71% to 92%, compared to the wavelet approach.

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***Title*** : ***Monitoring Depth Of Anesthesia Through The Measurement Of Eeg Single Complexity***  
***Author(s)*** : ***Krihnendu Chatterjee***  
***Roll No*** : ***Y210416***  
***Supervisor(s)*** : ***Ray G C***

### ***Abstract***

In this thesis, depth of anesthesia (DOA) is determined by measuring consciousness level during balanced anesthesia. Some mathematical techniques, like Correlation Dimension, Lempel-Ziv complexity analysis are applied on EEG signal to find the signal complexity. Theoretical concepts behind these methods are described in this thesis. These techniques are then applied on EEG dataset obtained from the experimental setup to determine brain activity level. The hardware and the software architecture is discussed in details.

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*Title* : *Adaptive Wavelet Transforms Using Lifting Framework*  
*Author(s)* : *Padlikar Tushar*  
*Roll No* : *Y210442*  
*Supervisor(s)* : *Sharma Govind*

### *Abstract*

In this thesis, a lifting based non-linear wavelet transform is proposed. This transform changes its filter support size adaptively depending on the data. A simple criterion for this adaptive change is proposed. The basic idea is to avoid using a large support size filter across the abrupt signal discontinuities (edges). This performs better than conventional linear algorithms. The reason being smaller number of wavelet coefficients is affected because of the edges. This gives an effective coding gain. The data itself is used for making the decisions, hence no side information needs to be sent along with the data. For coding the transformed image the SPIHT coder has been modified. The results of proposed transform are much better in case of synthetic test images and comparable in case of natural images. Future extensions to the algorithms have been proposed.

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*Title* : *Design Of An Adaptive Biasing Circuit To Improve The Dynamic Performance Of CMOS OP-AMPS Operating In Subthreshold Region*

*Author(s)* : *Girish Kurkure*

*Roll No* : *Y210410*

*Supervisor(s)* : *Dutta Alope*

### *Abstract*

For low power applications, it is required that the stand-by power consumption of the circuits should be very low. In order to achieve this, circuits can be operated at very low current levels by operating the MOSFETs contained therein in their subthreshold mode of operation. However, this severely affects the dynamic performance of the circuits, in particular, the transient response and the slew rate. In this work, a new adaptive biasing scheme for differential amplifiers (DAs), operating in the subthreshold region and thus suitable for low-voltage and low-power applications, has been proposed. This circuit provides an additional bias current, over and above the normal bias current for the DA, which is proportional to the differential signal between the two inputs of the DA, thus having the prospect of improving the dynamic response. The designed circuit has been used in an Operational Transconductance Amplifier (OTA) with a 1:1:1 V power supply, and it has been shown that the positive slew rate has improved from 2.92 V / f.Ls to 1242 V / f.Ls, and the negative slew rate from 1.5625 V / f.Ls to 133 V / f.Ls. At the same time, the small-signal performance parameters (i.e., gain margin and phase margin) remained almost the same as that without adaptive biasing (as expected), and there was a small decrease of the dynamic range [(+913 mV to -915 mV) from (+907 mV to -902 mV)]. The most useful feature of the proposed biasing circuit is that it requires a negligible amount of standby power as compared to the previously developed circuits reported in the literature. This reduction in the stand-by power is due to the fact that no additional quiescent current source is required in the proposed circuit, unlike those reported earlier.

*Title* : *Improved Inversion Charge Approximation In The EKV MOS Model*  
*Author(s)* : *Kulkarni Rajendra*  
*Roll No* : *Y210426*  
*Supervisor(s)* : *Dutta Alope*

### *Abstract*

In this work, the linear inversion charge approximation used in the basic EKV model, which causes discontinuity in the device characteristics between the weak and the strong inversion regions, is improved by the use of correction factors, which are obtained based on device physics and curve fitting techniques. Three types of correction methods were employed here: the constant factor correction, the slope and the constant factor correction, and the quadratic type correction. It is observed that the use of these correction factors reduced the error in the inversion charge in the moderate inversion region considerably, thus allowing a smooth transition of the device characteristics, from the weak to the strong inversion region; however, the complexity of the optimization process increased as the number of the correction factors were increased. The effect of these correction parameters on the drain current, transconductance, and intrinsic capacitance characteristics, which are obtained from the modified inversion charge model, were observed. It has been shown that the constant factor correction method gives excellent match with the theoretical characteristics, retaining the simplicity of the basic model and needing the least time for optimization without requiring any intense numerical calculations. For the charge based EKV model, a new formulation for the charge linearization factor has been proposed in this work here, which contains only technology parameters and does not need any fitting parameters. This is a significant contribution of this work. Use of this new formulation has resulted in excellent match of the

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*Title* : *Leakage Currents In Deep SUB-Micron CMOS Circuits And Their Suppression Techniques*  
*Author(s)* : *Ankur Goel*  
*Roll No* : *Y 210403*  
*Supervisor(s)* : *Mazhari Baquer*

### *Abstract*

Thesis title: "LEAKAGE CURRENTS IN DEEP SUB-MICRON CMOS CIRCUITS AND THEIR SUPPRESSION TECHNIQUES". Name of the thesis supervisor: Month and year of thesis submission: Dr. B. Mazhari July 2004. In this work two approaches for reducing gate leakage currents in SRAM are examined in detail. In one approach, the supply voltage to cell is reduced while in the other the potential of the ground node of the SRAM cell is raised, during the inactive mode, using a dynamic self-controllable switch. It is proposed that the scheme in which supply voltage level is reduced is more efficient in reducing gate leakage than the one in which ground node potential is raised. Simulation results based on BPTM (Berkeley Predictive Technology Model) for 45nm channel length device show that 96% reduction in the leakage currents of SRAM can be achieved. A novel asymmetric cell is proposed to reduce the gate leakage in SRAM. The cell exploits the fact that most of the bits in SRAM are 'Q'. Simulation results show that 51% reduction in the total leakage currents was achieved with marginal speed loss.

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*Title* : *A 1- Volt Class AB CMOS Buffer Amplifier*  
*Author(s)* : *Rathi Amit Kumar*  
*Roll No* : *Y210402*  
*Supervisor(s)* : *Mazhari Baquer*

### *Abstract*

A CMOS Class AB pseudo-source buffer amplifier is presented which achieves rail-to-rail operation at a supply voltage of  $\pm 0.5V$  while driving low impedance loads. A dynamic level-shifting approach is used to implement error amplifiers in a push-pull unity gain amplifier configuration. The output stage includes a simple current control which accurately sets the output quiescent current. Simulation results for a complete 1-V opamp incorporating a bulk driven input differential stage and the proposed low voltage buffer amplifier are presented for a standard 0.51 $\mu m$  CMOS technology.

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