ACADEMIC AFFAIRS OFFICE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

No. Acd./1684 /IAPC-111 Dated: October 09 , 2021

Head, Department of Electrical Engg.

The IAPC in its 111th meeting held on 22.09.2021 vide Item No. 111.2.5 considered and approved the following proposals of Department of Electrical Engg. with minor modifications:

1. To introduce following PECs: **(Appendix-A)**

   a) EEN-673: Design of WBG Device based Power Converters
   b) EEN-674: Machine Learning for Signal Processing
   c) EEN-366: Applied Machine Learning

2. Revision of syllabus of existing course i.e., EEN-204: Microprocessors and Peripheral Devices. **(Appendix-B)**

Assistant Registrar (Curriculum)

Encl: as above

Copy to (through e mail):-

1. All faculty
2. Head of all Departments / Centres
3. Dean, Academic Affairs
4. Associate Dean of Academic Affairs (Curriculum)
5. Chairman, DAPC of Deptt. of Electrical Engg.
6. Channel i/ Acad portal/ Academic webpage of iitr.ac.in

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electrical Engineering

1. **Subject Code:** EEN-673 **Course Title**: Design of WBG Device based Power Converters
2. **Contact Hours:** **L:** 3 **T:** 0 **P:** 2/2
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 15-30 **PRS:** 20 **MTE:** 15-25 **ETE:** 30-40 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Spring **7. Subject Area:** PEC
8. **Pre-requisite:** First course in Power Electronics
9. **Objective:** To impart knowledge of modern wideband gap (WBG) based power devices, their applications in power electronics, their gate driver circuits, issues related with the WBG based power PCB design, and high frequency power electronics design.

10. **Details of the Course**

S.No.	Contents	Contact hours
1.	**Introduction and SiC**: Introduction to wideband gap devices, motivation for WBG device, SiC device static and dynamic characteristics	4
2.	**GaN and WBG Comparison:** GaN transistor static and dynamic characteristics, methods for characterization; Si vs SiC vs GaN; Si vs SiC vs IGBT	4
3.	**WBG Applications and challenges**: High switching frequency DC/DC converters, motor drives, battery chargers, resonant converters	2
4.	**Gate driver design**: Gate driver requirement, circuits, topologies, its impact on device characteristics, gate driver design using device parameters, protection circuits, gate driver power supply design, gate driver losses	6
5.	**Parasitic Management:** Types of parasitic: loop inductances, parasitic capacitances, gate driver loop inductance, common source inductance, device output capacitance, lead inductances; parasitic impact on device losses and switching behavior, parasitic management methods, low inductance loop design, low parasitic capacitance layout	4
6.	**PCB design:** Schematics development steps, layout steps, different packages, soldering schemes, material for PCBs, layout guidelines, design for manufacturing	4
7.	**High frequency power electronics design**: Skin effect, proximity effect, sources of EMI, DC-link capacitor selection, switching loss, conduction loss, capacitor ESR loss, soft switching	8
8.	**Magnetics design:** Basics of magnetics, high-frequency transformer design, filter inductor design, selection of core, interleaving of windings, core loss	7
9.	**Case Study:** understanding the datasheet of one SiC and GaN devices	3
Total		**42**

Following are the list of lab exercises:

1) Creation of footprint for the sample through-hole, SMD, 16-pin, BGA IC packages
2) Creation of two sample circuit schematics
3) Assignment of the footprint on the sample schematics, generation of bill of materials
4) Development of the Sample-I PCB layout
5) Development of the sample-II PCB layout
6) Development of SPICE model for switching loss computation of the GaN/SiC half bridge

11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Fei (Fred) Wang, Zheyu Zhang, and Edward A. Jones, "Characterization of Wide Bandgap Power Semiconductor Devices", The Institution of Engineering and Technology.	2018
2.	Alex Lidow, Michael D Rooij, Johan Strydom, David Ruesh and John Glaser, "GaN Transistors for Efficient Power Conversion", 3rd Ed., Wiley.	2019
3.	Robert W. Erickson, and Dragan Maksimovic "Fundamentals of Power Electronics", 3rd Springer	2020
4.	L. Umanand, "Power Electronics: Essentials and Applications", Wiley India.	2012
5.	Mohan N., Underland T.M. and Robbins W.P., "Power Electronics – Converters, Applications and Design", 3rd Ed., Wiley India.	2008

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electrical Engineering

1. **Subject Code:** EEN-674 **Course Title**: Machine Learning for Signal Processing
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Both **7. Subject Area:** PEC
8. **Pre-requisite:** Digital Signal Processing
9. **Objective:** This course is intended to establish a fair association between machine learning techniques and signal processing algorithms.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	**Mathematical foundations and Basic concepts in machine learning:** Abstract algebras, Metrics, Vector spaces, Probability and stochastic processes, Data compression and information theory, Graphs, Convexity. Sampling, quantization, coding, and random sampling. Types of machine learning, Parametric and non-parametric models, linear regression, logistic regression, overfitting.	5
2.	**Optimization:** Preliminaries, Analytical and numerical methods for continuous convex problems, Continuous convex and non-convex problems.	4
3.	**Statistical modeling and inference**: Statistical models, Optimal probability inferences, Bayesian inference, Distributions associated with metrics and norms, the exponential family.	5
4.	**Probabilistic graphical models (PGM):** Statistical modelling with PGMs, Exploring conditional independence in PGMs Inference on PGMs.	5
5.	**Statistical machine learning:** Feature and kernel functions, Classification, Regression, Clustering, Dimensionality reduction.	6
6.	**Linear-Gaussian systems and signal processing:** LTI systems, LTI signal processing, Exploiting statistical stability for linear-Gaussian DSP, The Kalman filter, Time-varying linear systems.	6
7.	**Nonlinear and non-Gaussian signal processing:** Running window filters, Recursive filtering, Global nonlinear filtering, Hidden Markov models, Homomorphic signal processing.	6
8.	**Nonparametric Bayesian machine learning and signal processing:** Representations of stochastic processes, Partitions and equivalence classes, Gaussian processes, Dirichlet processes.	5
Total		**42**

11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Max A. Little, "Machine Learning for Signal Processing," Oxford University Press.	2019
2.	Moon T. K. and. Stirling W. C., "Mathematical Methods and Algorithms for Signal Processing," Prentice Hall.	2000
3.	Christopher M. Bishop., "Pattern Recognition and Machine Learning," Springer.	2006
4.	Murphy K. P., "Machine Learning: A Probabilistic Perspective," MIT Press, Cambridge.	2012
5.	Gonzalo R. Arce, "Nonlinear Signal Processing: A Statistical Approach," Wiley-Interscience.	2005

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electrical Engineering

1. **Subject Code:** EEN-366 **Course Title**: Applied Machine Learning
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 **6. Semester:** Spring **7. Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** To introduce students to the basic concepts and techniques of Machine Learning and to provide skills to apply these techniques on real applications.
10. **Details of the Course**

S.No.	Contents	Contact hours
1.	Introduction: Types of machine learning: Supervised Learning, unsupervised Learning, reinforcement Learning, examples of machine learning applications, model selection and generalization, concept learning, inductive learning, inductive bias, basics of information theory.	3
2.	Linear models for regression and classification: linear basis function models, maximum likelihood and least squares, regularized least squares, discriminant functions, Fisher's linear discriminant.	3
3.	Artificial neural networks: perceptron training rule, gradient descent rule, linear regression, multilayer networks and backpropagation algorithm, learning with momentum, regularization methods, dimension reduction, performance metrics: confusion matrix, receiver operating characteristics (ROC) curve.	5
4.	Decision tree learning: Decision tree representation, hypothesis space search in decision tree learning, avoiding overfitting the data, alternative measures for selecting attribute values, ensemble learning, gradient boosting, random forest.	5
5.	Bayesian Learning: Bayes theorem, maximum likelihood estimation, Naïve Bayes classifier, Probabilistic models, undirected models, inference using variables, sampling, EM algorithm, mixture of models, logistic regression.	6
6.	Support Vector Machines: Probably approximately correct (PAC) learning, sample complexity and VC dimension, linear SVM, soft margin SVM, nonlinear SVM, Multiclass classification using SVM, support vector regression.	5
7.	Instance based learning: k-nearest neighbor learning, distance weighted neighbor learning, locally weighted regression.	2
8.	Reinforcement learning: the learning task, Markov Decision process, nondeterministic rewards and actions, Bellman equations, value and policy iteration, Q learning, temporal difference learning.	4
9.	Deep Learning: Convolutional neural networks, auto-encoders, recurrent neural networks, long short-term memory networks (LSTM), generalized adversarial	6

	networks (GAN), Deep Q networks.	
10.	Machine learning applications to electrical engineering: Electrical load forecasting, wind and solar energy forecasting, fault identification and classification, reinforcement learning for control, Image classification and segmentation.	3
Total		**42**

11. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	T. Mitchell, Machine Learning, McGraw Hill	1997
2.	Alex Smola, S.V.N. Vishwanathan, Introduction to Machine Learning Cambridge University Press 2008.	2008
3.	Christopher Bishop, Pattern Recognition and Machine Learning, Springer	2006
4.	K. Murphy, Machine Learning: A probabilistic perspective, MIT Press	2012
5.	Hastie, Tibshirani, Friedman, Elements of statistical learning, Springer	2011
6.	I. Goodfellow, Y. Bengio and A. Courville, Deep Learning. MIT Press	2016
7.	Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, MIT Press	2018

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Electrical Engineering

1. **Subject Code:** EEN-204 **Course Title**: Microprocessors and Peripheral Devices
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 2
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 2
4. **Relative Weightage:** **CWS:** 10-25 **PRS:** 25 **MTE:** 15-25 **ETE:** 30-40 **PRE:** 0
5. **Credits:** 5 **6. Semester:** Spring **7. Subject Area:** PCC
8. **Pre-requisite:** Nil
9. **Objective:** To provide in-depth knowledge of the architecture, instruction set and programming of typical 16-bit microprocessor and programmable support chips.

10. **Details of the Course**

S.No.	Contents	Contact hours
1.	**Introduction of Microcomputer System**: CPU, I/O devices, clock, memory, bussed architecture, tri-state logic, address bus, data bus and control bus; Evolution of Microprocessors- Intel 8080, 8085, 8086, 8088, 80186, 80286, 80386, 80486.	3
2.	**Semiconductor Memories**: MROM, ROM, EPROM, EEPROM, DRAM, internal structure and decoding, memory read and write timing diagrams.	3
3.	**Introduction to 8-bit Processor:** Architecture of an 8-bit microprocessor (8085A), Pin configurations, state transition diagram; Memory interfacing; Addressing modes, instruction sets, Basics of assembly language programming; I/O techniques, Interfacing of I/O devices, LEDs and toggle-switches as examples; Interrupts.	8
4.	**Architecture**: Operation of 16-bit microprocessor: Pin configuration of Intel 8086/8088, Concept of Pipelining and memory segmentation, Logical address, Offset address, Physical Address, Bus Interface Unit and Execution Unit, Segment Registers; Minimum and Maximum modes of operation, Address bus, Data bus and Control Bus. Clock Generator Intel 8284, Memory Organization of memory address space.	7
5.	**Addressing Modes:** Data related addressing modes- Register, Immediate, Direct, Register Indirect, Based Relative, Indexed Relative and Based Indexed. Branch related addressing modes- Intrasegment Direct, Intrasegment Indirect, Intersegment Direct and Intersegment Indirect.	3
6.	**Instruction Set and Programming:** Machine Cycles, Data Transfer, Arithmetic, Bit Manipulation, String, Program Execution transfer and Processor Control Instructions; Macro-assembler, Segment definition and Models; Subroutines; Assembler Directives.	7
7.	**Interrupt Structure of 8086**: Interrupt Pointer, Type numbers, Processing of interrupt, Internal and External interrupts, Interrupt Priorities, BIOS routines.	4
8.	**Programmable Support Chips**: Programmable parallel interface Intel 8255, Programmable interval timer Intel 8253, Programmable interrupt controller Intel 8259, Programmable serial communication interface.	7
Total		**42**

11. List of Experiments:

1. Familiarization with 8086 Microprocessor based trainer kit
2. Write a program to
    a. Find sum of N Natural numbers
    b. Add two n-byte numbers
3. Write a program to
    a. Find maximum and minimum numbers of an array
    b. Sort the array in ascending or descending order
4. Write a program to
    a. Find sum of 100 BCD numbers
    b. Find 10's complement of a multi-byte number
    c. Subtract a multi digit BDC number from another multi digit BCD number
5. Write a program to
    a. Fill a block of memory with a data
    b. Block move the array from one location to other location
6. Write a program to
    a. Multiply a number by 10
    b. Convert BCD number to its equivalent binary
    c. Convert binary number to its equivalent BCD
7. Write a program to display any number on LCD/LED
8. Using PPI 8255 and I/O module, write a program to
    a. Read the status of keys and display its complement on LEDs
    b. Implement (a) ring counter (b) twisted ring counter
9. Using PIT 8253, write a program to
    a. Implement a delay of desired period.
    b. Measure the pulse width.
10. Using PIC 8259, write a program to check external interrupts.

12. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Hall D.V., "Microprocessor and Interfacing –Programming and Hardware", Tata McGraw Hill, New Delhi.	2006
2.	Liu Yu-Cheng and Gibson G.A., "Microcomputer Systems; The 808618088 Family", Prentice-Hall of India.	1983
3.	Bray B.B., "Intel 8086,18088, 80186,180187, 80286, 80386, 80486, Pentium and Pentium Pro Processors, Architecture, Design and Application", Prentice-Hall of India.	2006
4.	Mazidi M.A., Mazidi J.G., "The 80x86 IBM PC and Compatible Computers (Vol. I & II), Assembly Language, Design and Interfacing", Prentice Hall.	2003
5.	Triebel W.A. and Singh A., "The 8088 and 8086 Microprocessors, Programming Interfacing, Software, Hardware and Applications", Prentice Hall of India.	-
6.	Intel Manual	-