Course Structure

Semester 1					
Course No.	**Course Name**	**L**	**T**	**P**	**C**
EN661 (Modified)	Renewable Energy Systems Theory(Core) Course 1	3	0	0	6
XX xxx	Theory (Elective) Course 2	3	0	0	6
XX xxx	Theory (Elective) Course 3	3	0	0	6
EN 663	Operation and instrumentation	1	0	4	6
EN 667	Seminar course I	0	0	3	3
		10	**0**	**7**	**27**

Semester 2					
Course No.	**Course Name**	**L**	**T**	**P**	**C**
EN 668	Seminar course 2	0	0	3	3
EN 697	Project 1	0	0	22	22
		0	**0**	**25**	**25**

Semester 3					
Course No.	**Course Name**	**L**	**T**	**P**	**C**
EN 669	Seminar course 3	0	0	3	3
EN 698	Project 2	0	0	22	22
		0	**0**	**25**	**25**

Semester 4					
Course No.	**Course Name**	**L**	**T**	**P**	**C**
EN 670	Seminar course 4	0	0	3	3
EN 699	Project 3	0	0	22	22
		0	**0**	**25**	**25**
GRAND TOTAL CREDITS					**102**

DETAILS OF COURSES

MODIFIED Theory (Core)course - 1 (EN 661)

EN 661 Renewable Energy Systems (3-0-0-6)

Preamble:

Renewable Energy Systems will be one of the two theory courses to be offered for MS(R) students in the Centre for Energy. This is to note that the students of MS (R) will be from multidisciplinary background. Therefore a theory course comprising of all areas of renewable energy is essential. The proposed course comprises of five key areas: bioenergy, solar energy, hydro-thermal energy, fuel cell and Non-conventional energy. An equal emphasis will be given in each of these five areas to make students familiar with overall renewable energy system.

Course Contents:

Various sources of renewable energy and their systems; Bioenergy: introduction to biofuels, feedstocks for biofuel production, biodiesel, bioethanol, biobutanol, biohydrogen, biogas and biooil, thermochemical methods of biofuel utilization (pyrolysis and gasification), concept of biorefinery; Solar energy: solar thermal conversion devices, storage and applications, solar cell fundamentals, different solar cell technologies, photovoltaic systems, solar assisted heating and cooling systems; Hydro-thermal energy: mini/micro-hydel systems, wave energy and ocean thermal energy conversion; Fuel cell: importance for fuel cell, classification of fuel cells, basic principle, design, materials used for developing fuel cells, applications and future prospects; Non-conventional energy: wind energy conversion, hydrogen energy, MHD, thermoelectric, thermionic, thermo-nuclear fusion technology.

Texts and References:

1. H. P. Garg and Jai Praksh, *Solar Energy Fundamentals and Applications*, TMH, 2000.
2. P. Takahashi and A. Trenka, *Ocean Thermal Energy Conversion*, John Wiley, 1994.
3. C. Y. Wereko-Brobby and E. B. Hagan, *Biomass Conversion and Technology*, John Wiley, 1997.
4. J. F. Walker and N. Jenkins, *Wind Energy Technology*, John Wiley and Sons, 1997.
5. D. D. Hall and R. P. Grover, *Biomass Regenerable Energy*, John Wiley, 1987.
6. J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon, 1986.
7. T. Jiandong, Z. Naibo, W. Xianhaun, H. Jing, and D. Huishen, *Mini Hydropower*, John Wiley, 1996.
8. G. Boyle, (Ed.), *Renewable Energy, Power for a Sustainable Future*, The Open University/Oxford University Press, 1996.
9. R. O. Hayre, S. W. Cha, W. Colella and F. B. Prinz, *Fuel Cell Fundamentals*, Wiley, 2008.
10. B. E. Logan, *Microbial Fuel Cells*, Wiley, 2007.
11. A. Luque and S. Hegedus (Eds.), *Hand book of Photovoltaic Science and Engineering*, 2nd Edn., John Wiley, 2011.

Theory (Elective) courses 2 and 3 :

As the students will be from different disciplines, they can choose the 2nd and 3rd theory (Elective) courses from other departments as deemed fit. A representative list of the course is shown in **Appendix 1**

EN 663 Operation and Instrumentation (1-0-4-6)

Course Contents:

Operation and instrumentation of the equipments involved in the energy research. The course will be designed to offer theoretical and practical knowledge of the key equipments in the field of bioenergy, solar energy, hydrothermal energy, fuel cell and non-conventional energy.

Texts and References:

1. N. Kularatna, *Digital and analogue instrumentation: testing and measurement* , IEEE, London, 2003.
2. G. W. Ewing (Ed.), *Analytical instrumentation handbook* , 2nd Edn., Marcel Dekker, 1997.
3. F. Rouessac and A. Rouessac, *Chemical analysis: modern instrumentation methods and techniques*, 2nd Edn., Jojn Wiley & Sons, 2007.

EN 667 Seminar course I (0-0-3-3)

EN 668 Seminar course II (0-0-3-3)

EN 669 Seminar course III (0-0-3-3)

EN 670 Seminar course IV (0-0-3-3)

Appendix 1

Course No.	Course Title	L - T - P – C
BT 601	Analytical Biotechnology	3 - 0 - 0 – 6
BT 603	Molecular Biophysics	3 - 0 - 0 – 6
BT 604	Enzymology	3 - 0 - 0 – 6
BT 605	Gene Therapy	3 - 0 - 0 – 6
BT 606	Food Biotechnology	3 - 0 - 0 – 6
BT 607	Plant Biotechnology	3 - 0 - 0 – 6
BT 608	Microbial Biotechnology	3 - 0 - 0 – 6
BT 609	Bioprocess Engineering	3 - 0 - 0 – 6
BT 610	Frontiers in Bimolecular Simulation	3 - 0 - 0 – 6

BT 611	Molecular Marker Assisted Breeding in Plants	3 - 0 - 0 – 6
BT 612	Systems Biology	3 - 0 - 0 – 6
BT 613	Plant Molecular Farming	3 - 0 - 0 – 6
BT 614	Fungal Biotechnology	3 - 0 - 0 – 6
BT 616	Molecular Virology	3 - 0 - 0 – 6
BT 617	Concepts and Methods in Proteomics	3 - 0 - 0 – 6
BT 618	Biomaterials	3 - 0 - 0 – 6
BT 619	Essentials of Genetics	3 - 0 - 0 – 6
BT 620	Biosensors	3 - 0 - 0 – 6
BT 621	Advances in Plant Genetic Engineering and Functional Genomics	3 - 0 - 0 – 6
BT 622	Biofuels	3 - 0 - 0 – 6
BT 624	Fluorescence Techniques in Biotechnology	3 - 0 - 0 – 6
BT 628	Metabolic Engineering	3 - 0 - 0 – 6
BT 633	Human Biology and Diseases	3 - 0 - 0 – 6

Course No.	Course Title	L	T	P	C
ME 501	Advanced Engineering Mathematics	3	0	2	8
ME 511	Advanced Materials and Processing	2	0	2	6
ME 512	Mechatronics and Manufacturing Automation	3	0	0	6
ME 513	Physics of Manufacturing Processes	3	0	0	6
ME 514	Computer Integrated Manufacturing	3	0	0	6
ME 515	Manufacturing Laboratory	0	0	6	6
ME 520	Fluid Mechanics	3	0	0	6
ME 522	Convective Heat and Mass Transfer	3	0	0	6
ME 523	Advanced Thermodynamics	3	0	0	6
ME 530	Advanced Mechanics of Solids	3	0	0	6
ME 531	Mechanical Vibration	3	0	0	6
ME 532	Finite Element Methods in Engineering	3	0	0	6
ME 541	Continuum Mechanics	3	0	0	6
ME 542	Numerical Analysis	2	0	2	6
ME 543	Computational Fluid Dynamics	3	0	0	6
ME 544	Computational Mechanics Lab	0	0	2	2
ME 551	Aerodynamics [Modified]	3	0	0	6
ME 553	Gas Dynamics [Modified]	3	0	0	6
ME 602	Computational Fluid Dynamics and Heat Transfer	3	0	0	6
ME 603	Radiative Heat Transfer in Participating Media	3	0	0	6
ME 604	Conduction and Radiation	3	0	0	6
ME 605	Fracture, Fatigue and Failure Analysis	3	0	0	6
ME 606	Solidification Processing	3	0	0	6

ME 607	Introduction to Composite Materials	3	0	0	6
ME 608	Computer Aided Design-Computer Aided Manufacturing	2	0	2	6
ME 609	Optimization Methods in Engineering	3	0	0	6
ME 613	Nonlinear Vibrations	3	0	0	6
ME 614	Random Vibrations	3	0	0	6
ME 615	Rotor Dynamics	3	0	0	6
ME 621	Refrigeration and Air-Conditioning	3	0	0	6
ME 625	Fracture Mechanics	3	0	0	6
ME 626	Aero-acoustics of Exhaust Systems	3	0	0	6
ME 627	Industrial Noise Control	3	0	0	6
ME 632	Condition Monitoring of Machines	3	0	0	6
ME 640	Robotics and Robot Applications	3	0	0	6
ME 643	Material Characterization Methods	3	0	0	6
ME 644	Modern Control	3	0	0	6
ME 645	Mechatronics	2	0	2	6
ME 647	Numerical Prediction of Industrial Fluid Flows	3	0	0	6
ME 648	Viscous Fluid Flow	3	0	0	6
ME 649	Analysis & Identification in Rotor Bearing Foundation Systems	3	0	0	6
ME 650	Gas Turbine Theory	3	0	0	6
ME 651	Numerical Methods for Thermal Radiation Heat Transfer	3	0	0	6
ME 652	Principles of Heat Transfer in Porous Media	3	0	0	6
ME 653	Jet Propulsion	3	0	0	6
ME 654	Wind Energy Conversion	3	0	0	6
ME 655	Energy Conservation and Waste Heat Recovery	3	0	0	6
ME 656	Numerical Simulation and Modelling of Turbulent Flows	3	0	0	6
ME 657	Two-phase Flow and Heat Transfer	3	0	0	6
ME 658	Signal Processing and Model Estimation	3	0	0	6
ME 659	Tribology of Bearings	3	0	0	6
ME 661	Computer Aided Engineering Design	3	0	0	6
ME 662	Combustion	3	0	0	6
ME 664	Theory of Elasticity	3	0	0	6
ME 665	Experimental Stress Analysis	3	0	0	6
ME 666	Plastics Engineering	3	0	0	6
ME 667	Sorption Cooling and Heating Systems	3	0	0	6
ME 669	Thermal Hydraulics in Power Generation Technology	3	0	0	6
ME 670	Advanced Computational Fluid Dynamics	3	0	0	6

ME 671	Biomaterials: Design and Applications	3	0	0	6
ME 672	Welding Science and Technology	3	0	0	6
ME 674	Soft Computing in Engineering	3	0	0	6

Course No.	**Course Title**	L	**T**	**P**	**C**
EE 562	Fundamentals of VLSI CAD	3	0	0	6
EE 621	Advanced Topics in Random Processes	3	0	0	6
EE 623	Advanced Topics in Signal Processing	3	0	0	6
EE 624	Image Processing	3	0	0	6
EE 625	Computer Vision	3	0	0	6
EE 626	Biomedical Signal Processing	3	0	0	6
EE 627	Speech Signal Processing and Coding	3	0	0	6
EE 628	Speech Technology	3	0	0	6
EE 632	Mobile Communications	3	0	0	6
EE 633	Queuing Systems	3	0	0	6
EE 635	Advanced Topics in Communication Systems	3	0	0	6
EE 636	Detection and Estimation Theory	3	0	0	6
EE 637	Error Control Codes	3	0	0	6
EE 638	Multimedia Security	3	0	0	6
EE 639	Sparse Representations & Compressive Sensing	3	0	0	6
EE 651	Multivariable Control Theory	3	0	0	6
EE 653	Nonlinear Systems and Control	3	0	0	6
EE 657	Pattern Recognition and Machine Learning	3	0	0	6
EE 659	Modeling and Simulation of Dynamic Systems	3	0	0	6
EE 660	Biometrics	3	0	0	6
EE 672	Intelligent Sensor and Actuator	3	0	0	6
EE 673	Synchrophasor Technology	3	0	0	6
EE 674	High Voltage Transmission	3	0	0	6
EE 680	Electric and Hybrid vehicles	3	0	0	6
EE 682	Advanced Electric Drives	3	0	0	6

Course No.	**Course Title**	L	**T**	**P**	**C**
CL 611	Advanced Process Control	3	0	0	6
CL 612	Colloid and Interface Science	3	0	0	6
CL 613	Computational Fluid Dynamics	3	0	0	6
CL 614	Fluidization Engineering	3	0	0	6
CL 615	Optimization Techniques	3	0	0	6
CL 617	Petrochemicals	3	0	0	6
CL 618	Natural Gas Engineering	3	0	0	6
CL 619	Refinery Process Design	3	0	0	6
CL 620	Nonlinear Bifurcation Analysis	3	0	0	6

CL 621	Fuel Cell Technology	3	0	0	6
CL 622	Molecular Simulation: Principles and Application	3	0	0	6
CL 623	Polymer Science and Technology	3	0	0	6
CL 624	Computing in Chemical and Petroleum Engineering	3	0	0	6
CL 625	Fundamentals of micro-nano fluidics & microfabrication	3	0	0	6

CL 626	Energy Resources	3	0	0	6
CL 627	Multiphase Flow	3	0	0	6
CL 628	Catalysts and Adsorbents	3	0	0	6
CL 629	Membranes	3	0	0	6
CL 630	Composite Materials	3	0	0	6
CL 631	Smart Materials	3	0	0	6
CL 632	Integration of Refinery and Petrochemical Operations	3	0	0	6
CL 633	Applied Statistical Thermodynamics	3	0	0	6

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