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UNIVERSITY OF MUMBAI

Revised Syllabus for the M. E. Program

Program: M.E.(Mechanical Engineering)-
AUTOMOBILE ENGINEERING

(As per Credit Based Semester and Grading System with effect from the academic year 2012–2013)

Program Structure for
ME Mechanical Engineering (Automobile Engineering)
Mumbai University
(With Effect from 2012-2013)

Semester I

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut	Theory	Pract.	Tut.	Total
AEC101	Numerical Methods & Computational Techniques	04	--	--	04	--	--	04
AEC102	Vehicle Engine Technology	04	--	--	04	--	--	04
AEC103	Noise Vibration and Harshness	04	--	--	04	--	--	04
AEE101X	Elective I	04	--	--	04	--	--	04
AEE102X	Elective II	04	--	--	04	--	--	04
AEL101	Laboratory I - Engine & Emission	--	02	--	--	01	--	01
AEL102	Laboratory II - Vibration Measurement and Analysis[#]	--	02	--	--	01	--	01
Total		**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
AEC101	Numerical Methods & Computational Techniques	20	20	20	80	03	--	--	**100**
AEC102	Vehicle Engine Technology	20	20	20	80	03	--	--	**100**
AEC103	Noise Vibration and Harshness	20	20	20	80	03	--	--	**100**
AEE101X	Elective I	20	20	20	80	03	--	--	**100**
AEE102X	Elective II	20	20	20	80	03	--	--	**100**
AEL101	Laboratory I - Engine & Emission	--	--	--	--	--	25	25	**50**
AEL102	Laboratory II - Vibration Measurement and Analysis[#]	--	--	--	--	--	25	25	**50**
Total		**--**	**--**	**100**	**400**	**--**	**50**	**50**	**600**

Subject Code	Elective I	Subject Code	Elective II
AEE1011	Advanced Finite Element Analysis*	AEE1021	Emission Control
AEE1012	Advanced Stress Analysis*	AEE1022	Computational Fluid Dynamics%
AEE1013	Rapid Prototyping and Tooling*	AEE1023	Tribology#
AEE1014	Vehicle Dynamics	AEE1024	Vehicle Instrumentation & Testing
AEE1015	Automotive Maintenance	AEE1025	Hydraulic and Pneumatic Systems

 # Common for Machine Design and Automobile Engineering

*** Common for Machine Design, Automobile Engineering and CAD/CAM and Robotics**

% Common for Machine Design, Automobile Engineering, CAD/CAM and Robotics and EnergyEngineering

Semester II

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract	Tut	Theory	Pract	Tut.	Total
AEC201	System Modeling and Analysis[#]	04	--	--	04	--	--	04
AEC202	Autotronix	04	--	--	04	--	--	04
AEC203	Automotive Chassis & Body Engineering	04	--	--	04	--	--	04
AEE203X	Elective III	04	--	--	04	--	--	04
AEE204X	Elective IV	04	--	--	04	--	--	04
AEL203	Laboratory III - Computer Aided Design and Computer Aided Manufacturing[#]	--	02	--	--	01	--	01
AEL204	Laboratory IV - Measurement and Virtual Instrumentation[§]	--	02	--	--	01	--	01
Total		**20**	**04**	**--**	**20**	**02**	**--**	**22**

Subject Code	Subject Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg.					
AEC201	System Modeling and Analysis[#]	20	20	20	80	03	--	--	**100**
AEC202	Autotronix	20	20	20	80	03	--	--	**100**
AEC203	Automotive Chassis & Body Engineering	20	20	20	80	03	--	--	**100**
AEE203X	Elective III	20	20	20	80	03	--	--	**100**
AEE204X	Elective IV	20	20	20	80	03	--	--	**100**
AEL203	Laboratory III - Computer Aided Design and Computer Aided Manufacturing[#]	--	--	--	--	--	25	25	**50**
AEL204	Laboratory IV - Measurement and Virtual Instrumentation[§]	--	--	--	--	--	25	25	**50**
Total		**--**	**--**	**100**	**400**	**--**	**50**	**50**	**600**

Subject Code	Elective III	Subject Code	Elective IV
AEE2031	Product Lifecycle Management[@]	AEE2041	Automotive Air Conditioning
AEE2032	Automotive Safety	AEE2042	Automotive Passion & Soft Skills
AEE2033	Robotics[*]	AEE2043	Advanced Manufacturing Technology for Auto. Components
AEE2034	Micro Electro Mechanical Systems[@]	AEE2044	Smart Materials and Applications[*]
AEE2035	Automotive Aerodynamics	AEE2045	Automotive Power Transmission Systems

 # Common for Machine Design and Automobile Engineering

*** Common for Machine Design, Automobile Engineering and CAD/CAM and Robotics**

@ Common for Machine Design, Automobile Engineering, CAD/CAM and Robotics and Manufacturing Systems Engineering

§Common for Machine Design, Automobile Engineering and Thermal Engineering

Semester III

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
AES301	Seminar	--	06	--	--	03	--	03
AED301	Dissertation I	--	24	--	--	12	--	12
Total		--	**30**	--	--	**15**	--	**15**

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
AES301	Seminar	--	--	--	--	50	50	**100**
AED302	Dissertation I	--	--	--	--	100	--	**100**
Total		--	--	--	--	**150**	**50**	**200**

Semester IV

Subject Code	Subject Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Pract.	Tut.	Total
AED401	Dissertation II	--	30	--	--	15	--	15
Total		--	**30**	--	--	**15**	--	**15**

Subject Code	Subject Name	Examination Scheme						
		Theory				Term Work	Pract./ Oral	Total
		Internal Assessment			End Sem. Exam.			
		Test 1	Test 2	Avg.				
AED401	Dissertation II*	--	--	--	--	100	100	**200**
Total		--	--	--	--	**100**	**100**	**200**

Note:

- In case of Seminar, 01 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation I, 02 Hour / week / student should be considered for the calculation of load of a teacher
- In case of Dissertation II, 02 Hour / week / student should be considered for the calculation of load of a teacher

Subject Code	Subject Name	Credits
AEC101	**Numerical Methods And Computational Techniques**	**04**

Module	Detailed content	Hours
01	**Linear and Non Linear algebraic equation** (Review of Gauss – Elimination of Gauss- Seidel) ,LU Decomposition, Thomas algorithm for TDM.(Review of Bisection method, Newton –Raphson method), multivariable Newton- Raphson method .	**08**
02	**Curve Fitting** a) Least square regression:- i)(Review of Linear Regression, multiple linear regression) ii)Non-linear regression – Gauss –Newton Method, steepest Descent Method, Marquardt Method, multiple non linear regression. b) Interpolation &Extrapolation :- Review of quadratic, Lagrange's Interpolation), spline Interpolation, Double Interpolation, Extrapolation.	**08**
03	**Eigen values of matrices, Differentiation and Integration** Power method, Householder & Given's method, Ritishauser method for arbitrary atrices.(review of divided difference formulae), Romberg integration, Gauss quadrature for double & triple integration.	**08**
04	**Ordinary differential equations** Review of Euler's method, Heun's method, Mid- point metho, Runge-Kutta Method , system of equations, Multi step method, Explicit Adams, Moulton Technique, Stiff equations, Adaptive step size control, Adaptive RK method, Embedded RK method, Step size control. Higher order ODE –Shooting method. Non Linear ODE, collocation technique.	**10**
05	**Partial Differential equations** Solution of Parabolic, hyperbolic equations, Implicit & explicit schemes, ADI methods, Non linear parabolic equations- Iteration method, solution of elliptic equations- Gauss, Seidel & SOR method. Richardson method.	**10**
06	**Finite element methods** Weighted residual methods, Variational methods, Finite element Linear, triangular, Rectangular,quadrilateral, Introduction to Tetrahedron, & Hexahedron elements.	**08**
07	**Fourier Transform methods** Fourier Transform, Vibration Analysis, Vibration conditions under step acceleration and ramp up acceleration. Stastical methods and normal process, averages± 3σ methods, calculation templates.	**08**

References:

1. Steven C.Chapra, & Raymond P. Canale, 'Numerical methods for Engineers', TMH, Fifth edition.
2. AlkisConstantinides, 'Applied Numerical methods', McGraw Hill
3. M.K.Jain, 'Numerical solution of differential equations', Wiley Eastern,2nd Edition.

Assessment:

Internal: Assessment consists of two tests out of which; one should be compulsory class test (on minimum 02 Modules) and the other is either a class test or assignment on live problems or course project.

End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
AEC102	**Vehicle Engine Technology**	**04**

Module	Detailed content	Hours
01	**Engine Basic Theory**: Engine types and their operation – Classification – Operating cycles of S.I. and C.I. engines – Engine Design and Operating Parameters – Mean effective pressure – Volumetric efficiency – Typical design and operating data for I.C. engines – Two and four stroke engines – Typical performance curves for automotive engines – Performance maps, Performance - Testing of engines – turbo vehicles – jet engine propulsion.	**10**
02	**Fuel Supply in IC Engines**: Mixture distribution and inlet manifold, Multipoint fuel injection system. Injection system components, Jerk, Distributor, Rotary & Common Rail pumps, Maximum and minimum speed governors, Mechanical and Pneumatic governors, Injectors and spray characteristics, conventional and electronic ignition systems for SI engine.	**08**
03	**Combustion in IC Engines:**Premixed combustion, diffused combustion, laminar and turbulent combustion of fuels in engines. Droplet combustion, Cylinder pressure data and heat release analysis. Ignition and combustion in SI engine, Flame travel, Review of detonation, effect of various factors, Combustion chambers for SI engines. Combustion in CI engine, Ignition delay and diesel knock, Excess air supply and air motion. Combustion chamber for CI engines - Construction and Performance aspects, M-combustion chamber.	**10**
04	**Air induction:**Air filter, Manifolds, EGR, Supercharging-power required and effect on engine performance, different type of turbochargers.	**08**
05	**Engine Lubrication and Cooling Systems:** Friction estimates and Lubrication requirements, theory of lubrication, types of lubrication, splash lubrication system, petroil lubrication system, forced feed lubrication system.Air cooling and water cooling – thermosympon cooling, forced cooling systems. Fins and radiator - design aspects.	**08**
06	**Design of Engine Components:**Overall engine system parameter, configuration finalization, Design and Drawings of Piston, cylinder block & head, Connecting rod – Crankshaft, camshaft, valve train.	**08**
07	**Recent Trends in Engine Technology:**Lean Burn engine, Different approaches to lean bum, LHR engine, Surface ignition concept, catalytic ignition, homogenous charge compression ignition (HCCI) in diesel engines, variable valve timing and recent developments etc.	**08**

Text Books :

1. J.B.Heywood, 'Internal Combustion Engine Fundamentals', McGraw Hill Book Co, 1988.
2. V. Ganesan, 'Internal Combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint,

References:

1. Edward F .Obert, 'Internal combustion engines and air pollution' Harber and Row Publishers, 973.
2. M. Khovakh, 'Motor Vehicle Engines', Mir Publishers, Mascow,1976
3. W.H.Crouse and A.L.Anglin, 'Automotive Emission Control', McGraw Hill Book Co, 1995.
4. G.S.Springer and A.J.Patterson, 'Engine emissions and pollutant formation', 'plenum press, Newyork,1985.
5. ARAI & Western Section Proceedings, "I C Engine Design & Development", Jan 2009

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Subject Code	Subject Name	Credits
AEC103	**Noise Vibration and Harshness**	**04**

Module	Detailed content	Hrs
01	**NVH in the Automotive Industry** Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers.	**12**
02	**Sound and Vibration Theory** Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration.	**12**
03	**Test Facilities and Instrumentation** Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings., Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis	**12**
04	**Signal Processing** Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions.	**12**
05	**NVH Control Strategies & Comfort** Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimisation of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques.	**12**

Text Books:

1. Norton M P, Fundamental of Noise and Vibration, Cambridge University Press,1989
2. Munjal M.L., Acoustic Ducts and Mufflers, John Wiley, 1987

References :

1. Baxa, Noise Control of Internal Combustion Engine, John Wiley, 1984.
2. Ewins D. J., Model Testing : Theory and Practice, John Wiley,1995.
3. Boris and Kornev, Dynamic Vibration Absorbers, John Wiley, 1993.
4. McConnell K, “Vibration Testing Theory and Practice”, John Wiley, 1995.

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Subject Code	Subject Name	Credits
AEE1011	**Advanced Finite Element Analysis***	**04**

Module	Detailed content	Hours
1	• Introduction to FEA, General FEM procedure, • Approximate solutions of differential equations: FDM method, W-R technique, collocation least square sub-domain and Galerkin method • Numerical integration, Gauss quadrature in 2-D and 3-D • Structure of FEA program, Pre and Post processor, commercially available standard packages, and desirable features of FEA packages. • Principal of minimum total potential, elements of variational calculus, minimization of functional, Rayleigh-Ritz method, Formulation of elemental matrix equation, and assembly concepts.	**14**
2	**One Dimensional FEM:** • Coordinate system: Global, local, natural coordinate system. Shape functions: Polynomial shape functions, Derivation of shape functions, Natural co-ordinate and coordinate transformation, Linear quadratic and cubic elements, Shape functions using Lagrange polynomials. Convergence and compatibility requirement of shape functions. • One dimensional field problems: structural analysis (step-bar, taper-bar). Structural analysis with temperature effect, Thermal analysis, heat transfer from composite bar, fins. Fluid network and flow through porous medium, analysis of electrical network problems by FEA	**12**
3	• Trusses, Thermal effects in truss members, Beams. • Two dimensional finite elements formulations, Threenoded triangular element, Four-noded rectangular element, Four-noded quadrilateral element, derivation of shape functions: natural coordinates, triangular elements, and quadrilateral elements. • Six-noded triangular elements, Eight-noded quadrilateral elements, Nine-noded quadrilateral element. • Strain displacement matrix for CST element	**10**
4	• Penalty Method, Lagrange methods, Multipoint Constraints • Concept of Master/Slave entities • Examples of Contact problems. • Iso-parametric concepts, basic theorem, Iso-parametric, super-parametric, sub-parametric elements, Concept of Jacobian	**08**
5	• Finite element formulation of Dynamics, application to free-vibration problems, Lump and consistent mass matrices, Eigen value problems. • Transient dynamic problems in heat transfer and solid mechanics. • Introduction to time-integration methods: Implicit and Explicit methods, Convergence, Impact of Mesh quality on convergence	**08**

6	• Three dimensional elements: Tetrahedron, Rectangular prism (brick), Arbitrary hexahedron. • Three Dimensional polynomial shape functions, Natural co-ordinates in 3D, Three dimensional Truss(space trusses) • Introduction to material models: Introduction to plasticity (Von-Mises Plasticity), Hyper –elasticity. Generating and using experimental data to model material behaviour. • Errors in FEA, sources of errors, method of elimination, Patch test.	**08**

*** Common for Machine Design, Automobile Engineering and CAD/CAM and Robotics**

References:

1. O.C.Zienkiewicz, R.L.Taylor&J.Z.Zhu, "The Finite Element Method its Basis and Fundamentals", Butterworth-Heinemann,Elsevier
2. Reddy J. N., "Finite Element Method", McGraw-Hill
3. S.S.Rao, "The Finite Element Method in Engineering" , 4th Edition, Academic Press, Elsevier
4. U.S.Dixit, "Finite Element Methods for Engineers",Cengage Learning
5. P.Seshu, "Textbook of FE Analysis", Prentice Hall
6. Desai and Abel, "Introduction to Finite Elements Methods", CBS Publication
7. Tirupati R. Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering"
8. Erik Thompson, "Introduction to Finite Element Methods", Wiley India
9. H. Kardestuneer, "Finite Elements Hand Book"
10. R.D.Cook, "Concepts & Applications of Finite Element Analysis"
11. Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall of India
12. Huebener K.H., Dewhirst D.D., Smith D.E. and Byrom T.G., "The Finite Element Method for Engineers", John Wiley, New York
13. Logan, "Finite Element Methods" Cengage Learning
14. George Buchanan, "Finite Elements Analysis", McGrawHill
15. C.S.Krishnamoorthy, "Finite Elements Analysis", Tata McGraw-Hill
16. RobertCook, "Concept and Application of Finite Element Methods", Wiley India.

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Subject Code	Subject Name	Credits
AEE1012	**Advanced Stress Analysis***	**04**

Module	Detailed content	Hours
1	**Analysis of stress in three dimensions:** Stress at a point – components of stress; Principal stresses; Determination of principal stresses; Stress invariants; Determination of maximum shear stresses; Octahedral shear stress,Hydrostatic and Deviatoric Stress Tensors Mohr's Circle for 2D and 3D stress problem.	**12**
2	**Analysis of strain:** Strain at a point – Components of strain; Differential equations of equilibrium; Conditions of compatibility,Hydrostatic and Deviatoric Strain TensorsMohr's Circle for 2D and 3D strain problem.	**10**
3	**Stress Strain relationship:** Generalized Hooke's law,Elastic behavior for different materials (Isotropic, Orthotropic and Anisotropic).	**10**
4	**Electrical Strain Gauges:** Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheastone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators. Load cell and its types Introduction to Recent Trends in Strain Measurement	**08**
5	**Fatigue and Fracture:** Introduction to fatigue and fracture mechanics of ductile and brittle fractures mechanism of fatigue failure. Factors affecting fatigue. Methods of improving fatigue strength. Cumulative damage theories. Linear elastic fracture mechanics. Finite life, infinite life, design of machine components, Fracture toughness, Crack growth studies	**10**
6	**Environmental considerations in design:** Corrosion, corrosion under stress, fretting corrosion and effects of other chemicals. Methods of improving corrosion resistance.	**10**

*** Common for Machine Design, Automobile Engineering and CAD/CAM and Robotics**

References:

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, 1984.
2. M. Ameen, "Computational Elasticity", Narosa Publishing House.
3. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc., New York, 1998.
4. Cook and Young, "Advanced Mechanics of Materials", Prentice Hall
5. Richard G. Budynas, "Advanced Strength and Applied Stress Analysis", McGraw Hill
6. Boresi, Schmidt, "Advanced Mechanics of Materials", Sidebottom, Willey
7. Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill
8. Timoshenko, "Advanced Strength of Materials, Vol. 1,2", CBS
9. T.L. Anderson, "Fracture Mechanics – Fundamentals and Applications " CRC Press

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Subject Code	Subject Name	Credits
AEE1013	**Rapid Prototyping and Tooling***	**04**

Module	Detailed content	Hours
1	**Rapid Prototyping** • Historical Development • Applications: Design, Planning, Manufacturing and Tooling • Applications: Automotive, Jewelry, Coin and Bio-Medical • Fundamentals of Rapid Prototyping, Design Process • Rapid Prototyping Process Chain	**10**
2	**Subsystems of RP Machine** • Subsystems of RP machine o Optical System o Mechanical Scanning System o Computer Interfacing hardware, DAQs o Signal Flow, 3D Model to RP Prototype • Introduction to 3D Modeling Softwares (Auto-CAD, PROE, CATIA, IDEAs etc.) • Slicing and Scan Path Generation Algorithms • Data Conversion and Transmission • File Formats, IGES, STL • Preprocessing and Post-processing	**10**
3	**Liquid Based Rapid Prototyping Systems** • Materials • Stereolithography • Solid Ground Curing • Solid Object UV (Ultra-Violet) Printer • Two Laser System • Micro-stereolithography	**10**
4	**Solid Based Rapid Prototyping Systems** • Materials • LOM (Laminated Object Manufacturing) System • FDM (Fuse Deposition Modeling) System • Multi-Jet Modeling (MJM) System • Model Maker and Pattern Master • Shape Deposition Manufacturing Process	**10**
5	**Powder Based Rapid Prototyping Systems** • Materials • SLS (Selective Laser Sintering) • (3DP) Three-Dimensional Printing • (LENS) Laser Engineered Net Shaping • (MJS) Multiphase Jet Solidification • (EBM) Electron Beam Melting	**10**

6	**Advances in RP Systems and Case Studies** • Advances in RP: Resolution & Accuracy issues, Integrated Hardening Process, Two Photon Process for Micro/Nano Fabrication, Reverse Engineering Process and Applications. • Case Study: Wind-Tunnel Testing with RP Models • Case Study: Investment Casting with RP	**10**

*** Common for Machine Design, Automobile Engineering and CAD/CAM and Robotics**

References:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid Prototyping Principles and Applications", World Publishing Co. Pte. Ltd.
2. James O. Hamblen, and Michael D. Furman, "Rapid Prototyping of Digital Systems", Kluwer Academic Publishers.
3. Kenneth G. Cooper, "Rapid Prototyping Technology Selection and Application", 2001, Marcel Dekker Inc, New York.
4. Ali Kamrani, EmadAbouel Nasr, "Rapid Prototyping Theory and Practice", 2006, Springer Inc.
5. BopayaBidanda, Paulo J. Bartolo, "Virtual Prototyping and Bio Manufacturing in Medical Applications", 2008, Springer Inc.
6. I. Gibson, D.W. Rosen, and B. Stucker, "Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing", 2010, Springer Inc.

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Subject Code	Subject Name	Credits
AEE1014	**VEHICLE DYNAMICS**	**04**

Module	Detailed content	Hours
01	**Fundamentals of Vibration** Classification of vibration, definitions, mechanical vibrating systems, mechanical vibration and human comfort. Modeling and simulation studies. Single degree of freedom, free, forced and damped vibrations. Magnification factor and transmissibility. Vibration absorber. Vibration measuring instruments. Two degree of freedom system. modal analysis.	**12**
02	**Handling Characteristics of Vehicles** Steering geometry. Steady state handling characteristics. Steady state response to steering input. Transient response characteristics. Directional stability of vehicle.	**10**
03	**Tyres** Tire forces and moments, rolling resistance of tires, relationship between tractive effort and longitudinal slip of tyres, cornering properties of tyres, ride properties of tyre.	**10**
04	**Performance Characteristics of Vehicle** Equation of motion and maximum tractive effort. Aerodynamics forces and moments Power plant and transmission characteristics. Prediction of vehicle response to braking, crashworthiness of a vehicle.	**12**
05	**Dynamics of Suspension System** Requirements of suspension system. Spring mass frequency, wheel hop, Wheel wobble, wheel shimmy, choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and aft, Hydraulic dampers and choice of damping characteristics. Compensated suspension systems. Human response to vibration, vehicle ride model. Load distribution. Stability on a curved track, banked road and on a slope.	**16**

Textbooks:

1. Rao J.S and Gupta. K "Theory and Practice of Mechanical Vibrations", Wiley Eastern Ltd., 2002
2. J.Y.Wong,' Theory of ground vehicle', John Wiley and Sons Inc., Newyork, 1978
3. Dr. N. K. Giri, "Automobile Mechanics", Seventh reprint, Khanna Publishers, Delhi, 2005

References:

1. Groover, "Mechanical Vibration", 7th Edition, Nem Chand &Bros, Roorkee, India, 2003.
2. W.Steeds, 'Mechanics of road vehicle' Illiffe Books Ltd, London 1992
3. JG.Giles, 'Steering, Suspension tyres', Illife Books Lid London 1975
4. P.M.Heldt, 'Automotive chassis', Chilton Co ., Newyork, 1982
5. J. R. Ellis, 'Vehicle Dynamics', Business Books, London, 1969.

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Subject Code	Subject Name	Credits
AEE1015	**AUTOMOTIVE MAINTENANCE**	**04**

Module	Detailed content	Hours
01	Basics and principles of maintenance management – preventive and predictive techniques – proactive measures and RCM.	**10**
02	Failure statistics and Reliability concepts, Weibull distribution – application and limitations to vehicular applications	**10**
03	Maintenance planning and replacement strategies – organisation of maintenance resources, administrative structure and work planning and scheduling	**14**
04	Quantitative techniques like queuing theory, spares inventory control and network analysis.	**12**
05	Condition based maintenance and condition monitoring, Body and Engine Diagnostics and monitoring like visual, NDT, Vibration, thermal and oil contamination – computer aided analysis using fuzzy logic and Artificial Neural Networks (ANN) – development of expert systems for vehicular diagnosis – cost benefit analysis and economic for large fleet and ransportation.	**14**

Textbook:

1. Mechanics of Road Vehicles – W. Steed, Illefe Books Ltd. London
2. Automotive Chassis – P. M. Heldt, Chilton Co. NK

References:

1. Kelly & M.J. Harris – Management of Industrial Maintenance, Newnes – Butterworths Management library 1978
2. Steve Goldman – Vibration Spectrum analysis, Industrial press inc. 1999
3. R.A. Collacott – Mechanical fault diagnosis and condition monitoring, Chapman and Hall, 1977
4. Bosch – Automotive Handbook 2000
5. R.A. Collacott – Vibration monitoring and diagnosis, John Wiley & Sons, 1979
6. Frank Gradon – Maintenance engineering, Applied science publishers Ltd., 1973

Assessment:

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Subject Code	Subject Name	Credits
AEE1021	**EMISSION CONTROL**	**04**

Module	Detailed content	Hours
01	**Emissions from IC Engines and its Control:** Emission formation in S.I.engines – Hydrocarbons – Carbon monoxide – Nitric Oxide, Lead particulates –Polyneculear aromatic hydro carbon emission – Effects of design and operatingvariables on emission formation in spark ignition engines – Controlling of pollutant formation in engines – Thermal reactors – Catalytic converters – Charcoal Canister Control for evaporative emission – Positive crank case ventilation system for UBHC emission reduction. Chemical delay – Significance – Intermediate compound formation – Pollutant formation on incomplete combustion – effect of operating variables on pollutant formation – Controlling of emissions – Driving behavior – Fumigation – Exhaust gas recirculation – Air injection – Cetane number effect.	**14**
02	Exhaust Emission Control: Basic method of emission control, catalytic converter, After burners, reactor manifold, air injection, crank case emission control, evaporative loss control, Exhaust gas recirculation, Fuel additives.	**10**
03	Pollution Norms : European pollution norms, Indian pollution norms as per Central Motor Vehicle Rules (C.M.V.R.).	**08**
04	Instrumentation for Exhaust Emission Measurement: Measurement procedure, Sampling Methods, Orsat Apparatus, Infrared Gas analyzer, Flame Ionization Detector (FID), Smoke meters.	**10**
05	Alternative Fuels : CNG, LPG, Bio-Diesel, Hydrogen, fuel cells, Eco-friendly vehicles, Electric & Solar operated vehicle	**10**
06	Stratified Charged, Low heat rejection engine, Sankey plot, four / three valve engine, OHC engine, governing of automobile engine, New engine technology, Recent developments in emission control technologies.	**08**

Text Books:

1. Ganesan.V, Internal Combustion Engines, Tata McGraw Hill, 1994.
2. Crouse.W.M, Anglin.A.L., Automotive Emission Control, McGraw Hill 1995.
3. Springer.G.S, Patterson.D.J, Engine Emissions, pollutant formation, Plenum Press, 1986

References:

1. Patterson, D.J, Henin.N.A, Emissions from Combustion engines and their Control, Anna Arbor Science, 1985.
2. Linden.D, Handbook of Batteries and Fuel Cells, McGraw Hill, 1995.
3. Maxwell et al, Alternative Fuel : Emission, Economic and Performance, SAE, 1995
4. Watson, E.B., Alternative fuels for the combustion engine, ASME, 1990
5. Bechtold, R., Alternative fuels guidebook, 1998.
6. Joseph, N., Hydrogen fuel for structure transportation, SAE, 1996.

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Subject Code	Subject Name	Credits
AEE1022	**Computational Fluid Dynamics[%]**	**04**

Module	Detailed content	Hours
1	**Introduction:** Definition and overview of CFD, Advantages and applications, CFD methodology	**06**
2	**Governing Differential Equations:** Governing equations for mass, momentum and energy; Navier-Stokes equations; Mathematical behaviour of PDE's viz. parabolic, elliptic and hyperbolic, Initial and boundary conditions, Initial and Boundary value problems.	**10**
3	**Discretization Techniques:** Introduction to Finite difference Method, Finite Volume method and Finite Element method Finite difference methods; Finite difference representation of PDE's; Solutions to Finite Difference Equations; Implicit, semi-implicit and explicit methods; Errors and stability criteria	**12**
4	**Finite Volume Methods:** FVM solutions to steady one, two and three dimensional diffusion problems and unsteady one and two dimensional diffusion problems FVM solutions to convection-diffusion problems - one and two dimensional, steady and unsteady; Advection schemes; Pressure velocity coupling; SIMPLE family of algorithms	**14**
5	**Grid Generation:** Structured and Unstructured Grids; General transformations of the equations; body fitted coordinate systems; Algebraic and Elliptic Methods; multi block structured grids; adaptive grids	**10**
6	**Turbulence Modeling:** Effect of turbulence on governing equations; RANS, LES and DNS Models	**08**

% Common for Machine Design, Automobile Engineering, CAD/CAM and Robotics and Energy Engineering

References:

1. Muralidhar, K., Sundararajan, T., "Computational fluid flow and heat transfer", NArosa Publishing House, New Delhi1995
2. Ghosdhasdidar, P.S., "Computer simulation of flow and heat transfer", TataMcGraw-Hill Publishing company Ltd., 1998.
3. Subas, V.Patankar, "Numerical heat transfer fluid flow", Hemisphere publishing Corporation.
4. Taylor, C and Hughes J.B., "Finite Element Programming of the Navier Stokes Equation", Pineridge Press Ltd., U.K , 1981.
5. Anderson, D.A., Tannehill , I.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer", Hemisphere Publishing Corporation, New York , USA, 1984.
6. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics 1", Fundamental and General Techniques, Springer- Verlag , 1987

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Subject Code	Subject Name	Credits
AEE1023	**Tribology#**	**04**

Module	Detailed content	Hours
1	**Introduction** • Tribology • Historical Background • Industrial Importance • Friction and Wear • Lubricants - Types and Properties of Lubricants - Viscosity and Viscometry • Bearings	**06**
2	**Friction** • Introduction • Laws of Friction • Friction Theories • Other Mechanisms - Hysteresis - Ratchet Mechanism - Stick-Slip - Rolling Friction • Friction on Metals • Friction on Non-Metallic Materials **Wear** • Mechanisms of Wear: Abrasive, Adhesive, Surface Fatigue and Tribo-chemical • Quantitative Laws of Wear, Wear Resistance of Materials	**14**
3	**Rolling Element Bearings** • Introduction • Selection of Bearings • Stribeck's Equation • Static and Dynamic Load Carrying Capacity • Rated Life, Equivalent Bearing Load, Probability of Survival • Selection of Bearing from Design Data Book	**08**
4	**Hydrodynamic Bearings** • Introduction, Governing Equations • Hydrodynamic Journal Bearings, Hydrodynamic Thrust Bearings **Hydrostatic Bearings** • Introduction • Circular Step Thrust Bearing, Annular Thrust Pad Bearings, Rectangular Thrust Bearings • Hydrostatic Journal Bearings	**14**

5	**Gas Lubricated Bearings** • Introduction • Governing Equations • Infinitely Long - Plane Slider Bearings • Infinitely Long - Journal Bearings • Finite Journal Bearings • Other Gas Bearing Types - Tilted-Pad Journal Bearings - Spiral Groove Thrust and Journal Bearings - Foil Bearings - Externally Pressurized Bearings • Squeeze Film Lubrication • Instabilities in Gas-Lubricated Bearings	**10**
6	**Elastohydrodynamic Lubrication (EHL)** • Introduction • Line Contact: Rigid Cylinder • Line Contact: Elastic Cylinder • Point Contacts • Thermal Correction Factor • Surface Roughness Correction Factor • Lubricant Rheology • Different Regimes in EHL Contacts **Introduction to Nanotribology and Biotribology**	**08**

 # Common for Machine Design and Automobile Engineering

References:

1. Gwidon W. Stachowiak and Andrew W. Batchelor, "Engineering Tribology", Elsevier Butterworth Heinemann
2. PrasantaSahoo, "Engineering Tribology", PHI Learning Pvt. Ltd.
3. B.C. Majumdar, "Introduction to Tribology of Bearings", Wheeler Publishing
4. John Williams, "Engineering Tribology", Cambridge University Press
5. S.K. Basu, S.N. Sengupta and B.B. Ahuja, "Fundamentals of Tribology", PHI Learning Pvt. Ltd.

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Subject Code	Subject Name	Credits
AEE1024	**Vehicle Instrumentation & Testing**	**04**

Module	Detailed content	Hours
01	Planning & Measurement: Instrumentation – Selection of measuring instrument, requirements of measurement such as precision, accuracy, errors, sensitivity, readability and reliability.	**08**
02	Measurement of thermo physical properties: Devices to measure temperature and pressure of the working fluid, coolant, air and fuel flow into the engine.	**08**
03	Indicating and recording instruments: Vibrometer, Accelerometer, vibration and pressure pick ups, vibration test methods, Counters, stroboscopes, charge amplifiers, cathode ray oscillographs. FFT analyzer	**10**
04	Data acquisition and processing: General data acquisition system examples, storage, processing, recording and display devices	**06**
05	Factors affecting engine and vehicle performance and their fuel consumption ISI codes for testing automotive engines, Laboratory dynamometer testing systems of power train and vehicle under simulated conditions, Test tracks – Instrumentation for testing vehicles – for performance and endurance trails.	**10**
06	Warning and alarm instruments : Brake actuation warning system, traficators, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, gear neutral indicator, horn design, permanent magnet horn, air & music horns.	**10**
07	Dash board amenities : Car radio and stereo, courtesy lamp, time piece, cigar lamp, car fan, wind shield wiper, window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination.	**08**

Textbook:

1. Engineering Experimentation – Ernest O. Doeblin
2. Experimental Methods for Engineers – Holman J.P., McGraw Hill Book Co.

References:

1. Measurement Systems, Applications & Design – Ernest Doeblin, McGraw Hill Book Co.
2. Modern Electric Equipments for Automobiles – Judge A. W., Chapman Hall, London
3. Applied Instrumentation in Process Industries – Andrews W. G.

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Subject Code	Subject Name	Credits
AEE1025	**Hydraulic And Pneumatic Systems**	**04**

Module	Detailed content	Hours
01	**Introduction to Hydraulics / Pneumatics:** Hydraulic and Pneumatic system: Components, Applications in automotives. Hydraulic Fluids: Properties, Types, Factors affecting oil performance, Fire resistant hydraulic fluids. Hydraulic Power Unit: Hydraulic Pump, Oil reservoir, Oil filter. Fluid Power Lines: Layout requirement, Selection of pipe / tubing, Couplings. Packing and seals: Applications, Materials, Types, Packing standards, Factors affecting selection of packing and Seals..	**10**
02	**Source of Hydraulic / Pneumatic Power:** Pump: Pumping theory, Pump classification, Gear pumps, Vane pumps, Piston pumps, Pump performance, Pump noise, Pump selection, and Pump performance rating. Intensifier. Hydraulic Accumulator: Types, Applications. Compressor: Types of compressors, Compressor specification. Compressed air generation and distribution system.	**10**
03	**Hydraulic / Pneumatic Actuators:** Hydraulic cylinders, Mechanics of hydraulic cylinder loadings, limited rotation hydraulic actuator, Gear motors, Vane motors, Piston motors. Hydraulic motor theoretical torque, Power and Flow rate. Hydrostatic transmission, Hydraulic motor performance. Air cylinders and their design. Power operated holding devices. Air motors.	**08**
04	**Valves and Components in Hydraulic / Pneumatic systems:** Pressure, Direction and Flow Control valves. Servo valves, Cartridge valves, Hydraulic fuses, Switches, Control elements, PLC, Filter, Lubricator, Muffler, Dryer, Shuttle valve, Vacuum clamp. Etc.	**08**
05	**Hydraulic / Pneumatic Systems:** Fluid power symbols: IS, DIN, JIC, and ISO. Synchronizing the movement of fluid power rams, Dual pressure hydraulic systems, Safety controls for hydraulic systems, Sequencing of hydraulic cylinder motion. High pressure hydraulic systems. Pneumatic safety systems. Remote control pneumatic systems. Etc.	**08**
06	**Fluid Logic Control Systems:** Moving Part Logic (MPL) control system, MPL Control of fluid power circuits, Principles of Fluidic Logic Control, Basic Fluidic Devices, Fluid Sensors, Fluidic Control of Fluid Power Systems, Introduction to Boolean algebra, Examples.	**08**
07	**Hydraulic / Pneumatic System Design and Analysis:** Testing of hydraulic and pneumatic components as per standards. Testing equipments, procedure. Hydraulic system design, Analysis of hydraulic system with frictional losses, Accumulators system design. Analysis of electro hydraulic servo system, Hydraulic power unit design. Pneumatic system design considerations, Air pressure losses in pipelines, Economic cost of energy losses in pneumatic systems, Basic pneumatic circuits, and Pneumatic circuit analysis. Applications in automotives should be studied in detail. Design and analysis of any hydraulic / Pneumatic system in automotive application with selection of components from manufacturers' catalogue.	**08**

Textbooks:

1. H. L. Stewart – ‘Hydraulic and Pneumatic Power for Production’ Industrial Press Esposito - 'Fluid Power with application', Prentice hall
2. D.A.Pease - 'Basic Fluid Power', Prentice hall
3. J,J.Pipenger - 'Industrial Hydraulics', McGraw Hill
4. H.L.Stewart - 'Hydraulics and Pneumatics', Industrial Press
5. B. Lall- 'Oil Hydraulics', International Literature Association

References:

1. Yeaple - 'Fluid Power Design Handbook'
2. Vickers Manual on Industrial Hydraulics
3. Festo's Manual on Pneumatic Principle, applications
4. ISO - 1219, Fluid Systems and components, Graphic Symbols
5. Majumadar, "Oil Hydraulics- Principle & Maintenance", Tata McGraw Hill
6. Majumadar – ‘Pneumatic Systems’
7. Turner Ian C. – ‘Engineering Applications of Hydraulics and Pneumatics’ Arnold
8. S. Ilango and V. Soundarajan – ‘Introduction to Hydraulics and Pneumatics’, PHI

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Subject Code	Subject Name	Credits
AEL101	**Engine and Emission**	**01**

Module	Detailed content	Lab. Sessions
1	**Engine**: 1. Performance test on Gasoline engines 2. Performance & emission test on Genset diesel engine 3. Performance & emission test on CNG engine 4. Swirl & Flow tests of ports on steady state flow-bench.	**06**
2	**Emission**: 5. Performance & emission test on Heavy duty diesel engine (transient Dyno) 6. Study of Emission test for SI Engine 2 wheelers on Chassis Dynamometer. 7. Study of Emission test for SI Engine 3 wheelers on Chassis Dynamometer. 8. Study of Emission test for SI Engine 4 wheelers on Chassis Dynamometer.	**06**
3	**Fuel**: 9. Analysis of Carbonyl Compound from exhaust emission using HPLC. 10. Chemical Characterization of Gasoline and Diesel Fuel.	**03**

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
AEL102	**Vibration Measurement and Analysis#**	**01**

Module	Detailed content	Lab. Sessions
1	**Simulation study using mathematical simulation software (or any programming language) on** a. Single DOF system b. Multi DOF system	**03**
2	**Simulation study using finite element software on** a. Modal analysis b. Transient analysis c. Harmonic analysis d. Active vibration control	**06**
3	**Experimentation** a. Acquiring time domain vibration data by using sensors (displacement / velocity / acceleration) b. Processing the time domain data acquired in experiment 3 (a) using FFT tool to obtain vibration frequencies c. Performing modal analysis of beam / plate type structures d. Demonstration of condition based maintenance tool using vibration techniques	**06**

 # Common for Machine Design and Automobile Engineering

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
AEC201	**System Modeling & Analysis#**	**04**

Module	Detailed content	Hours
1	**Introduction to System & Mathematical Modeling** System, environment and variables, the state of a system,Physical Laws for Modeling of System, Representation of System in terms of Block Diagram, Reduction of Multiple Subsystems, Signal Flow Graph, Mason's Gain Formula	**10**
2	**Modeling in the frequency domain** Laplace Transform Review, The Transfer Function, Electrical Network Transfer Functions, Translational Mechanical System, Rotational Mechanical System, Transfer Functions for Systems with Gears, Electromechanical System, Fluid Systems, Thermal Systems, Electric Circuit Analogs, Nonlinearities, Linearization	**10**
3	**Modeling in the time domain** The General State-Space Representation, Applying the State-Space Representation, Converting a Transfer Function to State Space, Converting from State Space to a Transfer Function, Linearization	**08**
4	**Time response** Poles, Zeros, and System Response, First-Order Systems, The General Second-Order System, Underdamped Second-Order Systems, System Response with Additional Poles, System Response With Zeros, Effects of Nonlinearities Upon, Time Response, Laplace Transform Solution of State Equations, Time Domain Solution of State Equations	**08**
5	**Stability of System** Linear & Nonlinear System, Stability in Linear and Nonlinear System, Routh-Hurwitz Criterion, Routh-Hurwitz Criterion, Stability in State Space, Phase Plane Method for Nonlinear System **Root locus techniques** Introduction, Defining the Root Locus, Properties of the Root Locus, Sketching the Root Locus, **Frequency response techniques** Introduction, Asymptotic Approximations: Bode Plots, Introduction to the Nyquist Criterion, Sketching the Nyquist Diagram, Stability via the Nyquist Diagram, Gain Margin and Phase Margin via the Nyquist Diagram, Stability, Gain Margin, and Phase Margin via Bode Plots	**14**
6	**Advanced Modeling and Simulation Techniques** Introduction to Lyapunov Stability and Modeling via Lyapunov, Nonlinear Modeling Techniques such as consideration of Structural Nonlinearity and Material Nonlinearity	**10**

 # Common for Machine Design and Automobile Engineering

References:

1. Nicola Bellomo and Luigi Preziosi, “Modeling Mathematical Methods & Scientific Computations”, 1995, CRC Press.
2. I.J. Nagarath and M. Gopal, “Systems Modeling & Analysis”, Tata McGraw Hill, New Delhi.
3. Jan WillenPolderman and Jan C. Willems, “Introduction to Mathematical Systems Theory- A behavioral Approach”, 1998, Springer.
4. J.L. Shearer, A.T. Murphy and H.H. Richardson, “Introduction to System Dynamics”, 1971, Addison & Wesley.
5. Norman S. Nise, “Control Systems Engineering”, Sixth Edition, 2011, John Wiley & Sons, Inc.
6. Ogata, “Modern Control Engineering”, Prentice Hall
7. Ogata, “System Dynamics”, Pearson Education
8. Hung V Vu & R.S. Esfandi, “Dynamics Systems - Modeling and Analysis”, ThecGraw-Hill Companies Inc.

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Subject Code	Subject Name	Credits
AEC202	**Autotronix**	**04**

Module	Detailed content	Hours
01	**Fundamentals of Automotive Electronics** Components for electronic engine management system, open and closed loop control strategies, PID control, Look up tables, introduction to modern control strategies like Fuzzy logic and adaptive control. Parameters to be controlled in SI and CI engines.	**12**
02	**Sensors &Actuators :**Hall Effect, hot wire, thermistor, piezo electric, pizoresistive, based sensors. Introduction, basic sensor arrangement, types of sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor, Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, stepper motors, relays, detonation sensor, emission sensors.	**12**
03	**SI Engine Management** Feedback carburetor system, throttle body injection and multi point fuel injection system, injection system controls, advantage of electronic ignition systems, three way catalytic converter, conversion efficiency versus lambda. Layout and working of SI engine management systems like Bosch Monojetronic, L-Jetronic and LH-Jetronic. Group and sequential injection techniques. Working of the fuel system components. Advantages of electronic ignition systems. Types of solid state ignition systems and their principle of operation, Contactless electronic ignition system, Electronic spark timing control.	**12**
04	**CI Engine Management** Fuel injection system, parameters affecting combustion, noise and emissions in CI engines. Pilot, main, advanced, post injection and retarded post injection. Electronically controlled Unit Injection system. Layout of the common rail fuel injection system. Working of components like fuel injector, fuel pump, rail pressure limiter, flow limiter, EGR valve control in electronically controlled systems.	**12**
05	**Digital Engine Control System:** Open loop and close loop control system, enginecooling and warm up control, idle speed control, acceleration and full loadenrichment, deceleration fuel cutoff. Fuel control maps, open loop control of fuelinjection and closed loop lambda control exhaust emission control, on-boarddiagnostics, diagnostics, future automotive electronic systems, Electronic dash board instruments – Onboard diagnosis system.	**12**

Textbooks:

1. Automobile Electrical & Electronic Equipments - Young, Griffitns - Butterworths, London.
2. Understanding Automotive Electronics, Wiliam B. Ribbens, 5th Edition, Newnes, Butterworth–Heinemann.
3. Diesel Engine Management by Robert Bosch, SAE Publications, 3rd Edition, 2004
4. Gasoline Engine Management by Robert Bosch, SAE Publications, 2nd Edition,

References:

1. Understanding Automotive Electronics – Bechfold SAE 1998
2. Automobile Electronics by Eric Chowanietz SAE.
3. Fundamentals of Automotive Electronics - V.A.W.Hilliers - Hatchin, London
4. Automotive Computer & Control System – Tomwather J. R., Cland Hunter, Prentice Inc. NJ
5. Automotive Computers & Digital Instrumentation – Robert N. Brandy, Prentice Hall
6. Eaglewood, Cliffs, NJ
7. The Fundamentals of Electrical Systems - John Hartly - Longman Scientific & Technical
8. Automobile Electrical & Electronic Systems – Tom Denton, Allied Publishers Pvt. Ltd.

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Subject Code	Subject Name	Credits
AEC203	**Automotive Chassis & Body Engineering**	**04**

Module	Detailed content	Hours
01	**Introduction:** Layout with reference to prime mover location and drive. Frames, Constructional details – Materials – Testing of frames – Integrated body construction- Study of loads, moments and stresses on frame members, computer aided design of frame for passenger and commercial vehicles	**08**
02	**Steering System:** Front Axle types. Construction details. Materials. Front wheel geometry viz. Camber, kingpin inclination, caster, toe-in and toe-out. Conditions for true rolling motion of road wheels during steering. Steering geometry. Ackermann and Davis steering. Constructional details of steering linkages. Different types of steering gear boxes. Steering linkage layout for conventional and independent suspensions. Turning radius, wheel wobble and shimmy. Power and power assisted steering – Electric steering – Steer by wire	**08**
03	**Design of chassis system** Analysis of loads, moments and stresses at different sections of chassis components due to vibration - Design of propeller shaft, Design of final drive gearing, Design of full floating, semi-floating and three quarter floating rear shafts and rear axle housings.	**08**
04	**Braking System** Types of brakes. Principles of shoe brakes. Constructional details, materials. Braking torque developed by leading and trailing shoes. Disc brake theory, constructional details, advantages. Brake actuating system – mechanical, hydraulic, pneumatic. Factors affecting brake performance viz. operating temperature, area of brake lining, brake clearance. Exhaust brakes. Power and power assisted brakes - Antilock braking system , Retarded engine brakes, eddy retarders , Regenerative braking system – Brake by wire- Testing brakes – Road tests, garage tests and tests in the laboratory.	**08**
05	**Suspension System** Types of suspension. Factors influencing ride comfort, Suspension springs – leaf spring, shackle and mounting brackets, coil and torsion bar springs. Spring materials, Independent suspension – front and rear. Rubber, pneumatic, hydroelasitc suspension – Active suspension system . Shock absorbers – Magneto Rheological fluids . Types of wheels. Construction of wheel assembly. Types of tyres and constructional details. Static and rolling properties of pneumatic tyres - computer aided design of leaf springs, coil springs and torsion bar springs	**08**

06	**Car Body Details:**Types car bodies – Visibility: regulations, driver's visibility, methods of improving visibility – Safety: Safety Design, constructional details of roof, under floor, bonnet, boot, wings etc. **Bus Body Details:**Types of bus bodies. Floor height, engine location – Entrance and exit location, Constructional details, frame construction, Double skin construction, Types of metal sections used, regulations, Conventional and integral type construction. **Commercial Vehicle Details:**Types of bodies – Flat platform, drop side, fixed side, tipper body, tanker body. Construction of commercial vehicle bodies. Dimensions of driver's seat in relation to controls. Drivers cab design.	**08**
07	**Vehicle Aerodynamics** Objects – Vehicle drag and types. Various types of forces and moments. Effects of forces and moments various body optimization techniques for minimum drag. Principle of wind tunnel technology. Flow visualization techniques. Tests with scale models.	**06**
08	**Body Loads and Stress Analysis** Scalized structure – Structural surface – Shear panel method – Symmetric and Asymmetrical vertical loads in a car – Longitudinal loads – Different loading situations – Load distribution on vehicle structure – Stress analysis of bus body structure under bending and torsion – Stress analysis in integral bus body. Analysis of shock and impulse.	**06**

Textbooks:

1. William F. Milliken, Douglas L. Milliken, Maurice Olley, Chassis Design, SAE, 2002.
2. Crouse W.H- "Automotive Chassis and Body"- McGraw-Hill, New York- 1971.
3. Powloski, J., 'Vehicle Body Engineering', Business Books Ltd., 1989.
4. John Fenton, 'Vehicle Body Layout and Analysis', Mechanical Engineering Publication Ltd., London, 1982.
5. Vehicle Aerodynamics, SAE, 1996.

Reference Books:

1. Newton, Steeds and Garret, 'Motor Vehicle', Illifee Books Ltd., London, 1989.
2. The Automotive Chassis : Engineering principles - Prof. Dipl.-Ing. Jörnsen Reimpell,Dipl.-Ing. Helmut Stoll , Prof. Dr.-Ing. Jürgen W. Betzler
3. Giles.J.G- "Steering, Suspension and tyres"- Iiiffe Book Co., London- 1988.

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Subject Code	Subject Name	Credits
AEE2031	**Product Lifecycle Management@**	**04**

Module	Detailed content	Hours
1	**Introduction to Product Lifecycle Management (PLM):** Product Lifecycle Management (PLM), Need for PLM, Product Lifecycle Phases, Opportunities of Globalization, Pre-PLM Environment, PLM Paradigm, Importance & Benefits of PLM, Widespread Impact of PLM, Focus and Application, A PLM Project, Starting the PLM Initiative, PLM Applications **PLM Strategies:** Industrial strategies, Strategy elements, its identification, selection and implementation, Developing PLM Vision and PLM Strategy , Change management for PLM	**10**
2	**ProductDesign:** Product Design and Development Process, Engineering Design, Organization and Decomposition in Product Design, Typologies of Design Process Models, Reference Model, Product Design in the Context of the Product Development Process, Relation with the Development Process Planning Phase, Relation with the Post design Planning Phase, Methodological Evolution in Product Design, Concurrent Engineering, Characteristic Features of Concurrent Engineering, Concurrent Engineering and Life Cycle Approach, New Product Development (NPD) and Strategies, Product Configuration and Variant Management, The Design for X System, Objective Properties and Design for X Tools, Choice of Design for X Tools and Their Use in the Design Process	**10**
3	**Product Data Management (PDM):** Product and Product Data, PDM systems and importance, Components of PDM, Reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation **Virtual Product Development Tools:** For components, machines, and manufacturing plants, 3D CAD systems and realistic rendering techniques, Digital mock-up, Model building, Model analysis, Modeling and simulations in Product Design, Examples/Case studies	**10**
4	**Integration of Environmental Aspects in Product Design:** Sustainable Development, Design for Environment,Need for Life Cycle Environmental Strategies, Useful Life Extension Strategies, End-of-Life Strategies, Introduction of Environmental Strategies into the Design Process, Life Cycle Environmental Strategies and Considerations for Product Design	**10**
5	**Life Cycle Assessment and Life Cycle Cost Analysis:** Properties, and Framework of Life Cycle Assessment, Phases of LCA in ISO Standards, Fields of Application and Limitations of Life Cycle Assessment, Cost Analysis and the Life Cycle Approach, General Framework for LCCA, Evolution of Models for Product Life Cycle Cost Analysis	**10**

6	**Forecasting:** Evolution for technology forecasting and its importance, Future mapping, Methods of technology forecasting such as Relevance Trees, Morphological Methods and Mission Flow Diagram, Combining forecast of different technologies	**10**

@ Common for Machine Design, Automobile Engineering, CAD/CAM and Robotics and Manufacturing Systems Engineering

References:

1. John Stark, "Product Lifecycle Management: Paradigm for 21st Century Product Realisation", Springer-Verlag, 2004. ISBN: 1852338105
2. Fabio Giudice, Guido La Rosa, AntoninoRisitano, "Product Design for the environment-A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229
3. SaaksvuoriAntti, ImmonenAnselmie, "Product Life Cycle Management", Springer, Dreamtech, ISBN: 3540257314
4. Michael Grieve, "Product Lifecycle Management: Driving the next generation of lean thinking", Tata McGraw Hill, 2006, ISBN: 0070636265

Assessment:

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Subject Code	Subject Name	Credits
AEE2032	**Automotive Safety**	**04**

Module	Detailed content	Hours
01	Introduction to safety and Vehicle structural crashworthiness & Crash testing. Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology, Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Modeling and simulation studies, Optimization of vehicle structures for crash worthiness, Types of impacts, and Impact with rebound, movable barrier tests, Analysis and simulation of vehicle in barrier impacts, Roll over crash tests, Behavior of specific body structures in crash testing, Photographic analysis of impact tests, Regulatory requirements for crash testing.	**12**
02	**Ergonomics and Human response to Impact:** Importance of Ergonomics inAutomotive safety, Locations of controls, Anthropomerty, Human impact tolerance, Determination of Injury thresholds, Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria's and relation with crash and modeling and simulation studies in dummy.	**12**
03	**Vehicle safety systems:** Survival space requirements, Restraints systems usedautomobiles, Types of safety belts, Head restraints, Air bags used in automobiles, Use of energy absorbing systems in automobiles, Impact protection from steering controls, Design of seats for safety, types of seats used in automobiles. Importance of Bumpers in automobiles, Damageability criteria in bumper designs. Introduction to the types of safety glass and their requirements and rearward field of vision in automobiles, Types of rear view mirrors and their assessment. Warning devices, indicators, hinges, latches, wipers, horns, etc.	**12**
04	**Fundamentals of light, vision and colour:** Electromagnetic radiation and light, Propagation of light, Spectral sensitivity of light,Measures of radiation and light, Standard elements for optical control. Illuminant calculations, Derivation of luminous flux from luminous intensity, flux transfer and inter reflection, luminance calculations, discomfort glare, eyes as an optical system, visual processing, lighting for results, modes of appearance, Pointers for lighting devices. Nature of the colour, Tri-chromatic Colorimetry, Surface colour, colour spaces and colour solids, colour rendering.	**12**
05	**Light Measurements, Testing equipment, calibration and photometric practice:** Basics of standards and detectors, spectral measurements and Colorimetry, illuminant meters and luminance meters, colorimeters. Fundamentals of equipment used for light measurement in Automotive field; Gonio-Photometer, Reflecto-meter, Colorimeter, Integrating sphere, types, application, coordinates system, Types of sensors and working principle, construction, characteristics etc. used in different equipment. National and international Regulations, test requirements and testing procedure, Recent developments in Automotive Safety & Automotive lighting	**12**

Textbook:

1. Watts, A. J., et al "Low speed Automobile Accidents" Lawyers and Judges 1996
2. JullianHappian-Smith ‘An Introduction to Modern Vehicle Design’ SAE, 2002
3. Johnson, W., and Mamalis, A.G., "Crashworthiness of Vehicles, MEP, London, 1995

References:

1. Edward .A, Lamps and Lighting, Hodder& Stoughton, London, 1993.
2. Keitz H. A. E, Light calculations and Measurements, Macmillan, 1971.
3. Olson L. P, Forensic aspects of driver perception and response, Lawyers and Judges 1996.
4. Pantazis. M, Visual instrumentation: Optical design & engineering Principles, McGraw - Hill 1999.

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Subject Code	Subject Name	Credits
AEE2033	**Robotics***	**04**

Module	Detailed content	Hours
1	**Introduction:** Automation & robotics, Robotic System & Anatomy Classification, Future Prospects **Robotic Application in Manufacturing:** Material transfer, Machine loading & unloading, Processing operations, Assembly & Inspectors **Social Issues and Economics of robotics** **Drives:** Control Loops, Basic Control System Concepts & Models, Control System Analysis, Robot Activation & Feedback Components, Position & Velocity Sensors, Actuators , Power Transmission Systems**.**	**12**
2	**Robot &its Peripherals:** End Effecters - types, Mechanical & other grippers, Tool as end effecter **Sensors:** Sensors in Robotics, Tactile Sensors, Proximity & Range Sensors, Sensor Based Systems **Robotic Cell Design & Control.**	**08**
3	**Robot Kinematics**:Coordinate Frames, Rotations, Homogeneous Coordinates, Arm Equation of Planer Robot, Four axis SCARA Robot, TCV, Inverse Kinematics of Planer Robot, Four Axis SCARA Robot.	**12**
4	**Trajectory Planning & Robot Dynamics:**Manipulator Path Control- Linear, Quadratic and Cubic Interpolation, Work Space Analysis, Robot Dynamics – Langrangian Dynamics of one and two link robot arm	**08**
5	**Machine Vision:** Introduction, Low level & High level vision, Sensing &Digitising, Image processing & analysis, Segmentation, Edge detection, Object description& recognition, Interpretation, Noises in Image, Applications	**08**
6	**Programming For Robots:** Methods, Robot programme as a path in space, Motion interpolation, level & task level languages, Robot languages; Programming in suitable languages Characteristics of robot **Robot Intellgence& Task Planning:** Introduction, State space search, Problem reduction, Use of predictive logic, Means -Ends Analysis, Problem solving, Robot learning,Robot task planning.	**12**

*** Common for Machine Design, Automobile Engineering and CAD/CAM and Robotics**

References:

1. YoremKoren, “Robotics for Engineers”
2. J. F. Engelberger, “Robotics in Practice”
3. Ulrich Rembolds, ChristialBlume, “Computer Integrated Manufacturing Technology and Systems”
4. Ramamurthy, “Computer Aided Design in Mechanical Engineering”
5. Mark Spong, “Robot Dynamics and Control”, Wiley India
6. John Craig, “Robotics”
7. Paul R.P., “Robot Manipulators: Mathematics, Programming and Control”
8. Groover and Simmers, “Industrial Robotics”
9. Ernest Deoblin, “Measurement systems”
10. Beckwith and Lewisbuck, “Mechanical Measurements”
11. K. Ogata, “Modern Control Engineering”,PHI
12. Benjamin Kuo, “Automatic Control Systems”, Wiley India
13. Richard D. KIafter et al, “Robotic Engineering -an Integrated Approach”, PHI
14. Spyros G. Tzafestas, “Intelligent Robotic Systems”

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Subject Code	Subject Name	Credits
AEE2034	**Micro Electro Mechanical Systems[@]**	**04**

Module	Detailed content	Hours
1	**Introduction to MEMS & Applications** • Introduction to Micro-Electro-Mechanical Systems, • Applications and Materials, • Advantages & Disadvantages of Micro-sensors, and micro-actuators.	**08**
2	**Sensors and Actuators in Micro-domain** • Concept of Sensors & Actuators, • Sensing & Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys • Comb Drive Actuation & Sensing. Micro-mechanisms, Air-Bag Sensors, Chemical Sensors • Sensors & Actuators for Automotive, Biomedical, Industrial applications • Design of sensor and actuator for few applications such as automobile accelerometer, bimetallic temperature sensor, etc.	**12**
3	**Fabrication Methods** Microfabrication Methods (VLSI Techniques) • Positive and Negative Photoresists, • Bulk Micromachining, • Surface Micromachining, • Etching (Isotropic and Anisotropic), • Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques. 3D High Aspect Ratio Techniques • LIGA, • AMANDA, • Microstereolithography, • IH-Process, • X-Ray Techniques, • Ion-beam Lithography etc.	**10**
4	**Modelling and Simulation Techniques** • Scaling Laws, Governing Equations • Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal Laws, Fluid Flow Analysis • Micro-mechanism modelling and analysis techniques : Lumped Parameter Modelling and Distributed Parameter Modeling • Modelling of Micro-channel as heat exchanger, accelerometers, micro-hinges, compound microstructures. • Linear & Nonlinear Model. • Numerical Methods used for MEMS analysis.	**10**

5	**Characterization Techniques** Topography Methods (Optical, Electrical and Mechanical Methods) • Microscopy, STM (Scanning Tunneling Microscopes), • SEM (Scanning Electron Microscopes), SPM (Scanning Probe Microscopes),AFM (Atomic Force Microscopes) Mechanical Structure Analysis • Deformation & Vibration Measurement Techniques (Piezo resistive and piezo electric) • Interferometry Techniques, SPI (Speckle Pattern Interferometry), ESPI (Electronic Speckle Pattern Interferometry), • Laser Techniques, Laser Doppler Vibro-meters Fluid, Thermal and Chemical Analysis • Thermal Analysis Techniques (Theoretical and Experimental), Fluid Flow Pattern Analysis, Electro-chemical Analysis, • PIV Techniques • Spectroscopy	**12**
6	**Introduction to Advances of MEMS and Nanotechnology** • CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, • Nano-mechanical Systems (NEMS),Nano-tribology, &nano-indentation techniques, Domestic and Industrial Applications of nanotechnology • Molecular Modelling Techniques. • Social and Ethical Implications of nanotechnology in Society	**08**

@ Common for Machine Design, Automobile Engineering, CAD/CAM and Robotics and Manufacturing Systems Engineering

References:

1. Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim "Microsensors MEMS and Smart devices", John Wiley and sons, Ltd.
2. NadimMulaf and Kirt Williams, "An Introduction to Microelectromechanical systems Engineering", Artech House.
3. NicolaeLobontiu and Ephrahim Garcia, "Mechanics of Microelectromechanical systems", Kluwer Academic Publication.
4. Stanley Wolf and Richard Tauber, "Silicon Processing for the VLSI era Volume -1 Technology", Lattice press.
5. Vijay K. Varadan, K.J.Vinoy and S. Gopalkrishnan, "Smart Material Systems and MEMS: Design and Development Methodologies", John Wiley and sons Ltd.
6. Bhushan, "Springer Handbook of Nanotechnology", Springer Inc.

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End Semester Examination: Some guidelines for setting the question papers are as, six questions to be set each of 20 marks, out of these any four questions to be attempted by students.Minimum 80% syllabus should be covered in question papers of end semester examination.

Subject Code	Subject Name	Credits
AEE2035	**Automotive Aerodynamics**	**04**

Module	Detailed content	Hours
01	**Introduction** Scope – historical development trends – Fundamentals of fluid mechanics – Flow phenomenon related to vehicles – External & Internal flow problems – Resistance to vehicle motion – Performance – Fuel consumption and performance – Potential of vehicle aerodynamics.	**12**
02	**Aerodynamic Drag of Cabs** Car as a bluff body – Flow field around car – drag force – types of drag force – analysis of aerodynamic drag – drag coefficient of cars – strategies for aerodynamic development – low drag profiles.	**12**
03	**Shape Optimization Of Cabs** Front and modification – front and rear wind shield angle – Boat tailing – Hatch back, fast back and square back – Dust flow patterns at the rear – Effect of gap Configuration – effect of fasteners.	**12**
04	**Vehicle Handling** The origin of force and moments on a vehicle – side wind problems – methods to calculate forces and moments – vehicle dynamics Under side winds – the effects of forces and moments – Characteristics of forces and moments – Dirt accumulation on the vehicle – wind noise – drag reduction in commercial vehicles.	**12**
05	**Wind Tunnels For Automotive Aerodynamics** Introduction – Principles of wind tunnel technology – Limitation of simulation – Stress with scale models – full scale wind tunnels – measurement techniques – Equipment and transducers – road testing methods – Numerical methods.	**12**

Textbook:

1. Hucho, W.H., Aerodynamics of Road vehicles, Butterworths Co. Ltd., 1997.

References:

1. Pope, A, Wind Tunnel Testing, John Wiley & Sons, 2nd Edn., New York, 1994.
2. Automotive Aerodynamics: Update SP-706, SAE, 1987.
3. Vehicle Aerodynamics, SP-1145, SAE, 1996.

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Subject Code	Subject Name	Credits
AEE2041	**Automotive Air Conditioning**	**04**

Module	Detailed content	Hours
01	**Introduction:** methods of refrigeration, vapour compression refrigeration system,vapour absorption refrigeration system, applications of refrigeration & air conditioning, Automobile air conditioning, air conditioning for passengers, isolated vehicles, transport vehicles, applications related with very low temperatures	**08**
02	**Refrigerant :** Classification, properties, selection criteria, commonly used refrigerants, alternative refrigerants, eco-friendly refrigerants, applications of refrigerants, refrigerants used in automobile air conditioning	**08**
03	**Air Conditioning Systems & Components:** Classification, layouts, central / unitary air conditioning systems, components like compressors, evaporators, condensers, expansion devices, fan blowers, heating systems, Automotive heaters, Types, Heater Systems, Air conditioning protection, Engine protection.	**10**
04	**Load Analysis:** Outside & inside design consideration, factors forming the load on refrigeration & air conditioning systems, cooling & heating load calculations, load calculations for automobiles, effect of air conditioning load on engine performance.	**10**
05	**Air Distribution Systems :** Layout of duct system for automobile and impact on load, Distribution duct system, sizing, supply / return ducts, type of grills, diffusers, ventilation, air noise level, layout of duct systems for automobiles and their impact on load calculations	**08**
06	**Air Routine & Temperature Control :** Objectives - evaporator care air glow, through the dash recirculation unit, automatic temperature control, controlling flow, control of air handling systems, Common control such as thermostats, humidistat, control dampers, pressure cutouts, relays.	**08**
07	**Air Conditioning Maintenance and Service :** Air conditioner maintenance & service - servicing heater system, removing & replacing components, trouble shooting of air conditioning system, compressor service, methods of dehydration, charging & testing.	**08**

Textbooks:

1. Heating & Air Conditioning Systems – Mitchell Information Services
2. Paul Lung, "Automotive Air Conditioning", C.B.S. Publisher & Distributor, Delhi.
3. Harris, "Modern Air Conditioning".

References:

1. ASHRAE Handbook – 1985 Fundamentals
2. William H. Crouse & Donald L. Anglin, "Automotive Air Conditioning", McGraw Hill, Inc.,
3. Michel Information Services, Inc., Mitchell Automatic Heating & Air Conditioning Systems Prentice Hall, Inc. 1989.
4. Paul Weisler, "Automotive Air Conditioning", Reston Publishing Co. Inc. 1990

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Subject Code	Subject Name	Credits
AEE2042	**Automotive Passion & Soft Skills**	**04**

Module	Detailed content	Hours
01	**Introduction** Introduction to Soft Skills, Personality Development and Human Values, Self Awareness & Esteem, Perception and Attitudes, Self-Assessment& SWOT Analysis,Career Plan & Personal Goal setting, Building Personal Brand, Johari Window and Leadership	**12**
02	**Communication and Skill Building** Communication Skills, Verbal Communication, Written communication, Body Language, Event Management, How to write Report & SAE Papers, Paper Review,Book Review, Presentation, Intelligence Building, Emotional Quotient,IntelligenceQuotient & Memory Improvement, Cracking Written tests, Interviews & GroupDiscussions.	**12**
03	**Ethics and Etiquettes:** Professional Ethics & Etiquettes, Business Ethics, Corporate Ethics, Engineering Ethics, Office Etiquettes, Email Etiquettes, Telephone Etiquettes, Lunch/Dinner Etiquettes Social and Public Etiquettes.	**12**
04	**Soft Skills at Workplace:** How an Industry Works, Various Departments of Industry, Industry Review, Teambuilding & Motivation, Auto Passion, Confidence Building, Product DevelopmentCycle, Customer Satisfaction and Benchmarking	**12**
05	**Business/Work Success:** Time Management, Interpersonal Skills, Negotiation Skills, Delegating Skills, Executive Summary & Business Report, Handling of Difficult People, Business Analysis, Business Strategy, Meeting Skills, Stress Management & Meditation, Knowledge Management, Project Management, Performance Management System,Total Quality Management.	**12**

Textbooks:

1. Narian Ram, Twelve Management Sills for Success, Viva Books, 2006.
2. Dr Bond Allan, Your Masters Thesis, Viva Books, 2006.
3. Verity Judith, Succeeding at Interviews, Viva Books.
4. High Jana L., High Tech Etiquettes, Viva Books.
5. Haynes Marion E., Effective Meeting Skills, Viva Books.

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Subject Code	Subject Name	Credits
AEE2043	**Advanced Manufacturing Technology For Auto. Components**	**04**

Module	Detailed content	Hours
01	**Powder Metallurgy and Processing of Plastics** Powder metallurgy process, Process variables, manufacture of friction lining materials for clutch and brakes. Plastics - raw material - automobile components - molding- injection, compression and blow - PV foam molding- machining of plastics.	**14**
02	**Forming Process** Forging- process flow chart, forging of valves of valves, connecting rod, crank shaft, cam shaft, propeller shaft, transmission gear blanks, steering column. Extrusions: Basic process steps, extrusion of transmission shaft, housing spindle, steering worm blanks, Piston pin and valve tappets. Hydroforming: Process, hydro forming of exhaust manifold and comparison with conventional methods- Hydro forming of tail lamp housing- forming of wheel disc and rims. Stretch forming - Process, stretch forming of auto body panels - Super plastic alloys for auto body panels.	**14**
03	**Casting and Machining** Sand casting of cylinder block and liners - Centrifugal casting of flywheel, piston rings, bearing bushes, and liners, permanent mould casting of piston, pressure die casting of carburettor other small auto parts. Machining of connecting rods - crank shafts - cam shafts - pistons - piston pins - piston rings - valves - front and rear axle housings - fly wheel - Honing of cylinder bores - Copy turning and profile grinding machines.	**12**
04	**Gear Manufacturing** Gear milling, Hobbing and shaping, planing- Bevel gear production - Gear finishing and inspection.	**06**
05	**Recent Trends In Manufacturing of Auto Components** Powder injection moulding - Production of aluminium MMC liners for engine blocks - Plasma spray coated engine blocks and valves - Recent developments in auto body panel forming - Squeeze casting of pistons - aluminimum composite brake rotors.Sinter diffusion bonded idler sprocket- Gas injection molding of window channel - cast con process for auto parts.	**14**

Textbook:

1. Haslehurst.S.E., " Manufacturing Technology ", ELBS, London, 1990.
2. Rusinoff, " Forging and Forming of metals ", D.B. Taraporevala Son & Co. Pvt Ltd.,umbai,1995.
3. Sabroff.A.M. & Others, " Forging Materials & Processes ", Reinhold Book Corporation, NewYork,1988.

References:

1. Upton, " Pressure Die Casting ", pergamon Press, 1985.
2. High Velocity " Forming of Metals ", ASTME, prentice Hall of India (P) Ltd., New Delhi, 1990.

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Subject Code	Subject Name	Credits
AEE2044	**Smart Materials and Applications***	**04**

Module	Detailed content	Hours
1	**Introduction to Smart / Intelligent Materials:** Overview of Smart / Intelligent Materials, Primitive Functions of Intelligent Materials, Intelligence Inherent in Materials, Actuator Materials, Sensing Technologies, Microsensors, Intelligent Systems, Hybrid Smart Materials, Passive Sensory Smart Structures, Reactive Actuator based Smart Structures, Active Sensing and Reactive Smart Structures, Smart Skins	**08**
2	**Introduction to Highbandwidth - Low straingenerating (HBLS) SmartMaterials** **Piezoelectric Materials** constitutive relationship,electromechanicalcoupling coefficients,piezoelectric constants,piezoceramic materials,variation of couplingcoefficients in hard andsoft piezoceramics,polycrystalline vs singlecrystal piezoelectricmaterials, polyvinyldenefluoride, piezoelectriccomposites **Magnetostrictive Materials** constitutiverelationship, magnetomechanicalcouplingcoefficients, Joule Effect,Villari Effect, MatteuciEffect, Wiedemanneffect, Giantmagnetostriction inTerfenol-D, Terfenol-Dparticulate composites,Galfenol and Metglasmaterials.	**10**
3	**Actuators based on HBLSSmart Materials** **Piezoelectric Actuators** Induced Strain actuationmodel, Unimorph andBimorph Actuators,Actuators embedded incomposite laminate,Impedance matching inactuator design,Feedback Control, PulseDrive, Resonance Drive. **Magnetostrictive Actuators** Magnetostrictive MiniActuators, Thermalinstabilities, Discretelydistributed actuation,ManetostrictiveComposites. **MEMS based Actuators** PiezoelectricMicropumps,Magnetostrictivemicromechanisms,Imaging SystemApplications, InchwormDevices, Inkjet Printers,Piezoelectric Relays,Ultrasonic Motors, andMicroscale Walking Machines. **Sensors based on HBLSSmart Materials** Piezoelectric Sensors, MagnetostrictiveSensors, Techniques of Self-Sensing, MEMS Sensors	**12**
4	**Introduction to Lowbandwidth - High straingenerating (LBHS) materials** Shape Memory Alloys (SMA) Electro-active Polymers (EAP)	**08**
5	**Actuators based on LBHSSmart Materials** Shape Memory Alloy based actuators for Shape Control Electro-active Polymers for Work-Volume Generation **Sensors based on LBHSSmart Materials** EAP based sensors SMA based encoders, Optical Fibre based Sensing	**12**

6	**Advances in Smart Materials** • Active Fibre Composites (AFC) • Energy Harvesting Actuators and Energy Scavenging Sensors • Self-healing and Autophagous Smart Materials	**10**

*** Common for Machine Design, Automobile Engineering and CAD/CAM and Robotics**

References:

1. M.V. Gandhi and B.S. Thompson, "Smart Materials and Structures", Chapman &Hall,London; New York, 1992 (ISBN: 0412370107)
2. Bryan Culshaw, "Smart Structures and Materials", Artech House
3. Mel Scwartz, "Encyclopedia of Smart Materials Vol. I and II", John Wiley & Sons
4. SenolUtku, "Theory of Adaptive Structures : Incorporating Intelligence into Engineered Products", CRC Press
5. H. Janocha, "Actuators - Basics and Applications",Springer
6. B. Culshaw, "Smart Structures and Materials", Artech House, Boston, 1996 (ISBN: 0890066817)
7. A.V. Srinivasan, "Smart Structures: Analysis and Design", Cambridge University Press,Cambridge; New York, 2001 (ISBN: 0521650267)
8. A.J. Moulson and J.M. Herbert, "Electroceramics: Materials, Properties, Applications",2nd Edition, John Wiley & Sons, Chichester, West Sussex; New York, 2003 (ISBN:0471497479)
9. G. Gautschi, "Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers", Springer, Berlin; New York, 2002 (ISBN:3540422595)
10. K. Uchino, "Piezoelectric Actuators and Ultrasonic Motors", Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114)
11. G. Engdahl, "Handbook of Giant Magnetostrictive Materials", Academic Press, San Diego, Calif.; London, 2000 (ISBN: 012238640X)
12. K. Otsuka and C.M. Wayman, "Shape Memory Materials", Cambridge University Press, Cambridge; New York, 1998 (ISBN: 052144487X)
13. Eric Udd, "Fiber Optic Sensors: An Introduction for Engineers and Scientists", John Wiley & Sons, New York, 1991 (ISBN: 0471830070)
14. André Preumont, "Vibration Control of Active Structures: An Introduction", 2nd Edition, Kluwer Academic Publishers, Dordrecht; Boston, 2002 (ISBN: 1402004966)
15. HojjatAdeli, "Control, Optimization, and Smart Structures: High-Performance Bridges and Buildings of the Future", John Wiley, New York, 1999 (ISBN: 047135094X)
16. T.T. Soong, "Passive Energy Dissipation Systems in Structural Engineering", Wiley, Chichester; New York, 1997 (ISBN: 0471968218)

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Subject Code	Subject Name	Credits
AEE2045	**Automotive Power Transmission Systems**	**04**

Module	Detailed Content	Hours
01	**Clutch** Clutches- need, types-design of single plate clutch, multi plate clutch, centrifugal clutch, cone clutch, electromagnetic clutch, over running clutch - fluid coupling – clutch linkage – mechanical and hydraulic- clutch energy dissipated, torque capacity of clutch-trouble shooting – service procedure.	**14**
02	**Gear Box** Gearbox – need, speed selection – sliding mesh, constant mesh, synchromesh – over drives – gear shift mechanisms - total resistance to motion- traction and tractive effort - acceleration - calculation of gear ratio for vehicles - design of three speed gear box and four speed gear boxes- performance characteristics in different speeds - speed synchronizing devices, gear materials, lubrication – transfer case.	**10**
03	**Torque Converter and Automatic Transmission** Principal of torque conversion, single, multi stage and polyphase torque converters, performance characteristics, constructional and operational details of typical hydraulic transmission drives . Automatic transmission: relative merits and demerits when compared to conventional transmission – epicyclic and hydromatic transmission – continuously variable transmission	**14**
04	**Driveline** Effect of driving thrust and torque reactions - Hotchkiss drive, torque tube drive and radius rods - propeller shaft, universal joints, slip joint - front wheel drive - different types of final drive, double reduction and twin speed final drives – differential - construction details, non-slip differential, differential locks- rear axle assembly - types - multi axle vehicles – power train for hybrid vehicles.	**14**
05	**Power train design** Design of complete power train for a given engine power and vehicle load - clutch, gear box, propeller shaft, differential, rear axle and wheel.	**08**

Text books

1. Crouse W.H-"Automotive chassis and body"-McGraw-Hill, New York- 1971.
2. Giri. N.K. "Automobile Mechanics" Khanna Publishers – New Delhi – 2002.

References

1. Heldt P.M - Torque converters- Chilton Book Co.-1992
2. Newton Steeds & Garret- "Motor Vehicle"- Illiffe Books Ltd., London – 2000
3. Automotive chassis system – Thomas W .Birch .

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Subject Code	Subject Name	Credits
AEL203	**CAD/CAM/CIM#**	**01**

Module	Detailed content	Lab. Sessions
1	**CAD** a. Executing basic algorithms for generation of line, circle, ellipse in any programming language b. Executing transformations and projection both in 2D and 3D in any programming language c. Generating curves using any programming language	**06**
2	**CAM** a. Developing GM code or APT part program for machining operations such as facing, turning, threading, tapering, drilling, etc. and executing them on the CNC machine	**03**
3	**Laboratory Project** Geometric modeling and assembling of any mechanical system consisting of minimum 5 to 6 components using any CAD software and developing GM code or APT part program for manufacturing all the individual components on CNC machines	**06**

 # Common for Machine Design and Automobile Engineering

Assessment:

Laboratory Project : Weightage for Laboratory Project should be 40% in Final Assessment of Laboratory Work

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
AEL204	**Measurement and Virtual Instrumentation§**	**01**

Module	Detailed content	Lab. Sessions
1	Study of sensor characteristics, selection, calibration and measurement of minimum 05 mechanical parameters such as flow, load, pressure, speed and temperature	**05**
2	**Virtual Instrumentation** a. Simulation of any system with Virtual Instrumentation (VI) environment using any suitable software b. Interfacing of sensors used for measuring above mentioned parameters in I with VI software and measurement of these parameters on any laboratory model or actual working system	**08**
3	Demonstration of interfacing of VI software with suitable generic hardware	**02**

§**Common for Machine Design, Automobile Engineering and Thermal Engineering**

Assessment:

End Semester Examination: Practical/Oral examination is to be conducted by pair of internal and external examiners

Subject Code	Subject Name	Credits
AES301	**Seminar**	**03**

Guidelines for Seminar

- Seminar should be based on thrust areas in Automobile Engineering
- Students should do literature survey and identify the topic of seminar and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the topic and compile the report in standard format and present in front of Panel of Examiners.
- Seminar should be assessed based on following points
  - Quality of Literature survey and Novelty in the topic
  - Relevance to the specialization
  - Understanding of the topic
  - Quality of Written and Oral Presentation

NOTE :

1. Assessment of Seminar will be carried out by a pair of Internal and External examiner. The external examiner should be selected from approved panel of examiners for Seminar by University of Mumbai, OR faculty from Premier Educational Institutions /Research Organizations such as IIT, NIT, BARC, TIFR, DRDO, etc. OR a person having minimum Post-Graduate qualification with at least five years' experience in Industries.

2. Literature survey in case of seminar is based on the broader area of interest in recent developments and for dissertation it should be focused mainly on identified problem.

3. At least 4-5 hours of course on Research Methodology should be conducted which includes literature survey, identification of problems, analysis and interpretation of results and technical paper writing in the beginning of 3rd semester.

Subject Code	Subject Name	Credits
AED301 / AED401	**Dissertation (I and II)**	**12 + 15**

Guidelines for Dissertation

- Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

- Dissertation I should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization
  - Clarity of objective and scope
- Dissertation I should be assessed through a presentation by a panel of Internal examiners appointed by the Head of the Department/Institute of respective Programme.

Guidelines for Assessment of Dissertation II

- Dissertation II should be assessed based on following points
  - Quality of Literature survey and Novelty in the problem
  - Clarity of Problem definition and Feasibility of problem solution
  - Relevance to the specialization or current Research / Industrial trends
  - Clarity of objective and scope
  - Quality of work attempted
  - Validation of results
  - Quality of Written and Oral Presentation
- Dissertation II should be assessed through a presentation jointly by Internal and External Examiners appointed by the University of Mumbai
- Students should publish at least one paper based on the work in reputed International / National Conference (desirably in Refereed Journal)