Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed syllabus (DJ19)

Third Year B.Tech.

in

Mechanical Engineering

(Semester V and VI)

Revision: 1 (2019)

With effect from the Academic Year: 2021-2022

SHRI VILEPARLE KELAVANI MANDAL'S
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)

Scheme for Third Year of B.Tech. Program in Mechanical Engineering: Semester V (Autonomous)
(Academic Year 2021-2022)

Semester V

Sr	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)					Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Laboratory (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Term Work Total	CA Total (B)			
1	DJ19MEC501	Automotive Prime Movers	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19MEL501	Automotive Prime Movers Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
2	DJ19MEC502	Heat Transfer	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19MEL502	Heat Transfer Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
3	DJ19MEC503	Mechanical Vibrations	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19MEL503	Mechanical Vibrations Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
4	DJ19MEC504	Industrial Electronics and Controls	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19MEL504	Industrial Electronics and Controls Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
5@	DJ19MEC5011	Machine Tool Engineering	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**3**
	DJ19MEC5012	Renewable Energy Systems	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19MEC5013	Quality Engineering	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
6	DJ19MEL505	Python for Mechanical Engineering	--	2	--	1	--	--	--	--	25	25	--	--	--	25	25	50	1	**1**
7#	DJ19IHL2	Professional and Business Communication Laboratory	--	4	--	2	--	--	--	--	--	--	--	--	--	50	50	50	2	**2**
8	DJ19ILL1	Innovative Product Development - III	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	**1**
		Total	15	16	0	23	--	375	125	0	25	525	125	125	125	200	325	850	**23**	

@ Any 1 elective course

2 hrs. of theory (class wise) and 2 hrs of activity based laboratory (batch wise)

SHRI VILEPARLE KELAVANI MANDAL'S
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)

Scheme for Third Year of B.Tech. Program in Mechanical Engineering: Semester VI (Autonomous)
(Academic Year 2021-2022)

Semester VI

Sr	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)					Aggregate (A+B)	Credits earned	
			Theory (hrs.)	Laboratory (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total (A)	Term Test 1 (TT1)	Term Test 2 (TT2)	Avg (TT1 & TT2)	Term Work Total	CA Total (B)			
1	DJ19MEC601	Machine Design I	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19MEL601	Machine Design I Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
2	DJ19MEC602	Refrigeration and Air Conditioning	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19MEL602	Refrigeration and Air Conditioning Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
3	DJ19MEC603	Mechatronics	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19MEL603	Mechatronics Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
4	DJ19MEC604	Power Engineering	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**4**
	DJ19MEL604	Power Engineering Laboratory	--	2	--	1	--	--	25	--	--	25	--	--	--	25	25	50	1	
5@	DJ19MEC6011	Smart Materials	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	**3**
	DJ19MEC6012	Design of Heat Exchanger Equipments	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
	DJ19MEC6013	Reliability Engineering	3	--	--	3	3	75	--	--	--	75	25	25	25	--	25	100	3	
6	DJ19MEL605	Database Management Systems	--	2	--	1	--	--	--	--	25	25	--	--	--	25	25	50	1	**1**
7	DJ19ILL2	Innovative Product Development - IV	--	2	--	1	2	--	--	--	25	25	--	--	--	25	25	50	1	**1**
8	DJ19A5	Environmental Studies	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Total	**16**	**12**	**0**	**21**	--	**375**	**100**	**0**	**50**	**525**	**125**	**125**	**125**	**150**	**275**	**800**	**21**	

@ Any 1 elective course

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="4">Semester: V</td></tr>
<tr><td colspan="8">Course: Automotive Prime Movers</td><td colspan="4">Course Code: DJ19MEC501</td></tr>
<tr><td colspan="8">Course: Automotive Prime Movers Laboratory</td><td colspan="4">Course Code: DJ19MEL501</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
(Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="5">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
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<tr><td colspan="5">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">50</td></tr>
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</table>

Pre-requisite: Knowledge of thermodynamics and heat transfer.

Objectives:

1. To study the components of an internal combustion engine and its systems.
2. To familiarise with different systems in SI & CI engines.
3. To analyse engine performance and emissions.
4. To acquaint with modern hybrid and electric powertrains.

Outcomes: On completion of the course, learner will be able to:

1. Explain the construction and working of internal combustion engines.
2. Demonstrate the working systems of spark ignition & compression ignition engines.
3. Demonstrate the engine cooling, lubrication and super-charging systems.
4. Analyse various engine performance parameters.
5. Describe the different hybrid and electric powertrain systems.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus (Unit wise)		
Unit	**Description**	**Duration in Hours**
1	**Introduction** Classification of I.C. Engines, Components of I.C. Engines and their materials, Four stroke, two stroke engines and their comparison, Scavenging in two stoke engines; Fuel-air cycles and their analysis, Actual working cycle, Valve timing diagram. **Spark Ignition (SI) Engines** **Fuel supply system:** Air-Fuel mixture requirements for steady state and transient operations, Simple carburettor and its applications. **Fuel Injection systems:** Single-point and Multipoint injection systems, Gasoline Direct Injection. Engine Control Unit (ECU), Important sensors & actuators, Open loop and closed loop modes of operation. **Ignition systems:** Battery ignition system, Magneto ignition system, Electronic ignition systems. **Combustion:** Combustion phenomenon in SI Engines, Pressure-crank angle diagram, Abnormal combustion, Factors affecting combustion and detonation, Types of combustion chambers.	**10**
2	**Compression Ignition (CI) Engines** **Fuel Injection Systems:** Air injection systems, Airless/solid injection systems, Common rail, individual pump, distributor and unit systems. Injection pumps, Fuel injector, Types of nozzle, fuel atomization and spray structures, Electronically controlled unit fuel injection system. **Combustion:** Combustion phenomenon in C I engines, Stages of combustion, Delay period, Knocking, Pressure-Crank angle diagram, Factors affecting combustion and knocking, Types of combustion chambers.	**09**
3	**Engine cooling systems**: Necessity of engine cooling, Cooling systems and their comparison: Air cooling, Liquid cooling, Troubleshooting & maintenance. **Engine lubrication systems:** Types of lubricants and their properties, SAE rating of lubricants, Types of lubrication systems and their applications. **Supercharging/Turbo-charging:** Objectives and limitations, Methods, types and different arrangements of superchargers and turbochargers.	**06**
4	**Engine Performance & Emissions** Measurement and analysis of engine performance parameters, Performance characteristic of SI and CI engines, Effect of load and speed on engine performance & heat balance sheet. Engine exhaust control methods, Bharat Stage VI emission norms and control, Alternative fuels: Ethanol, Bio-diesel, CNG, LPG, Hydrogen, merits, demerits and engine modifications.	**09**
5	**Hybrid powertrain:** Different components of hybrid engines and hybrid powertrain designs, degree of hybridization. Hybrid vehicle operating modes. **Electric powertrain:** Electric BLDC motor, PMS motor, torque-speed characteristics, controllers, performance limits, and applications. **Current trends:** Camless engine, Variable valve timing, Stratification in GDI engines, LHR engine, HCCI engine & six stroke engine.	**08**

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

List of Laboratory Experiments

Part A: Study of systems in terms of constructional details and functions (Any 3)

1. 2 Stroke / 4 Stroke Engines.
2. Carburettor and auxiliary circuits.
3. Ignition system in SI engines.
4. Fuel injection system in CI engines.

Part B: Performance based experiments (Any 4)

1. Morse Test on petrol engine.
2. Speed Test on petrol or/and diesel engine.
3. Load Test on diesel engine.
4. Heat Balance test on diesel or petrol engines.
5. Experimental determination of Air fuel ratio and volumetric efficiency of the engine.

Books Recommended:

Text books:

1. Internal Combustion Engine, V Ganesan, 4th Edition, 2017, McGraw Hill
2. Internal Combustion Engine, Mathur and Sharma, 2014, Dhanpat Rai Publications
3. Internal Combustion Engines, H. N. Gupta, 2nd Edition, 2012, PHI
4. Internal Combustion Engines, R K Rajput, 3rd Edition, 2016, Laxmi Publications
5. Internal Combustion Engines Fundamentals, John B. Heywood, 2nd Edition, 2018, McGraw Hill

Reference Books:

1. Internal Combustion Engines, Willard W. Pulkrabek, 2nd Edition, 2013, Pearson Education.
2. Introduction to Internal Combustion Engines, Richard Stone, 4th Edition, 2012, Palgrave Publication
3. Automotive Electrical and Electronic Systems, Tom Denton, 5th Edition, 2017, Routledge
4. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad, Yimin, Sebastian, Ali, 3rd Edition, CRC Press

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which. Total duration allotted for writing each of the paper is 1 hr.
2. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 7 experiments, minimum 2 assignments, case-study/report on latest developments in I.C. engines/hybrid technology.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

The distribution of marks for term work shall be as follows:

i. Laboratory work (Experiments): 15 Marks
ii. Assignments: 05 Marks
iii. Case-study/Report: 05 Marks

The final certification and acceptance of term work will be subjected to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: V</td></tr>
<tr><td colspan="8">Course: Heat Transfer</td><td colspan="3">Course Code: DJ19MEC502</td></tr>
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</table>

Pre-requisite: Knowledge of

1. Basic Knowledge of physical science related to heat
2. Basic concepts learnt in fluid mechanics with respect to boundary conditions

Objectives:

1. To Study basic heat transfer concepts applicable for steady state and transient conditions
2. To Study mathematical modelling and designing concepts of heat exchangers

Outcomes: On completion of the course, learner will be able to:

1. Explain the mechanism of heat transfer by conduction and analyse various types of one-dimensional heat conduction problems.
2. Explain the mechanism of heat transfer by convection and analyse free and forced convection problems.
3. Find the rate of heat transfer by radiation and analyse the effect of radiation shield in radiation exchange between two surfaces.
4. Explain different types of heat exchangers and analyse heat exchanger using LMTD & NTU method.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in Hours**
1	**Basic concepts of heat transfer:** Definition, its importance in engineering applications, Physical Mechanism, Governing laws of heat transfer, Conduction mode: Thermal conductivity, Thermal diffusivity, Convection mode: Free and Forced convection, Heat transfer Coefficient, Radiation mode: Emissivity, transmissivity, reflectivity, absorptivity, Black body, Grey body, Opaque body, Steady and unsteady heat transfer, One dimensional, two dimensional and three dimensional heat transfer, Thermal resistance concept in heat transfer, Thermal contact resistance. **Conduction:** Three-dimensional differential equation for Conduction with heat generation in unsteady state in the Cartesian-coordinates, Solution of Fourier's equation for one-dimensional steady state Conduction through isotropic materials of various configurations such as plane wall, cylinder and sphere, composite wall, composite cylinders and composite spheres. (For cylindrical and spherical walls, derivation of Fourier's three-dimensional equation is NOT included.) Critical thickness of insulation and its importance.	**12**
2	**Heat transfer from Extended Surface:** Extended Surfaces and Transient Heat Conduction, Heat transfer from finned surface, Solutions for heat transfer through rectangular fins. Types of fins and their applications. Effectiveness and Efficiency of fins. **Unsteady state heat transfer:** Lumped system analysis, One dimensional transient problem analytical solution, Heisler charts. **Finite Difference Methods in Heat Conduction:** Introduction, Numerical Errors, Accuracy, One Dimensional steady state problems.	**08**
3	**Convection**: Natural and Forced convection, hydrodynamic and thermal boundary layers. Heat transfer coefficient. Effect of various parameters such as physical properties of the fluid, system geometry, fluid flow etc. on heat transfer coefficient. Physical significance of dimensionless numbers such as Nusselt's Number, Grashoff s Number, Prandtl's Number, Reynolds Number and Stanton's Number. Principle of dimensional analysis. Application of dimensional analysis to Convection for finding heat transfer coefficient. Empirical relations and their use for forced internal and external convection.	**08**
4	**Radiation:** Basic laws of radiation, Black body radiation, Planck's law, Kirchhoff's law, Wein displacement law, Lambert cosine law, Radiation intensity, Radiation heat exchange between black bodies, Shape factor algebra, Radiation heat exchange between nonblack bodies, Electrical network approach for radiation heat exchange: Radiosity and irradiation, Radiation shield	**07**
5	**Heat Exchangers:** Classification of heat exchangers. Logarithmic Mean Temperature Difference, Correction factor and effectiveness of heat exchangers. Effectiveness as a function of Number of Transfer Units and heat capacity ratio. Overall heat transfer coefficient, Fouling factor. Design consideration for Heat Exchangers. **Boiling and Condensation:** Boiling heat transfer, Pool boiling: different regimes and pool boiling curve, Flow boiling: Different Regimes and Boiling curve, Condensation heat transfer, Film condensation, Dropwise Condensation **Heat Pipe:** Introduction and application	**07**

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

List of Laboratory Experiments: (Any Six)

1. Measurement of thermal conductivity of solid/liquid
2. Measurement of heat transfer coefficient in natural convection
3. Measurement of heat transfer coefficient in forced convection
4. Measurement of Emissivity of Grey surface
5. Unsteady state heat transfer in cylinder/rod/wall
6. Determination of fin efficiency and fin effectiveness
7. Measurement of critical heat flux
8. Estimation of overall heat transfer coefficient and effectiveness of heat exchanger
9. Numerical modeling of any heat transfer problem using FDM

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept in depth.

Books Recommended:

Text Books:

1. Introduction to thermodynamics and Heat transfer; Yunus A Cengel; 2017; McGraw Hill International
2. Heat and Mass Transfer; PK Nag; 2011; McGraw Hill Education
3. Heat and Mass Transfer; R K Rajput; 2018; S Chand and company

Reference Books:

1. Fundamentals of Heat and Mass Transfer; Incropera, D P DeWitt; 2007; Wiley India
2. Heat Transfer; P S Ghoshdastidar; 2012; Oxford University Press
3. Heat and Mass Transfer; R Rudramoorthy, L Malaysamy; Pearson
4. Heat Transfer; J P Holman; 2017; Mcgraw Hill
5. Heat Transfer; S P Sukhatme; 2005; University Press
6. Heat and Mass Transfer; Mahesh Rathod; 2006; Laxmi Publication

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 6 experiments and minimum 3 assignments.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments: 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B. Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

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</table>

Pre-requisites: Knowledge of

1. Engineering Mechanics
2. Kinematics of Machinery

Objectives:

1. To study basic concepts of vibration analysis
2. To acquaint with the principles of vibration measuring instruments
3. To acquaint with the practices of monitoring health conditions of the systems

Outcomes: Learner will be able to…

1. Develop mathematical model to represent dynamic system
2. Evaluate natural frequency of mechanical element / system
3. Analyze response of mechanical element / system, executing free and forced vibration.
4. Estimate the values of various elements of vibrating systems, required to achieve vibration isolation and control
5. Analyze working of vibration measuring instruments

Syllabus for Third Year of B. Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus (unit wise)
Note: Some problems can be solved using python programming (or any other tools), using methods such as numerical methods and basic scripting

Module	Content	Duration (hrs.)
1	**Basic Concepts of Vibration:** Introduction, Elements of Vibrating Systems, Degrees of Freedom of Vibrating System, Classification of Vibrating Systems, General steps in analysis of vibrations **Free Vibrations of Single-Degree-of-Freedom Systems:** Free Undamped Vibrations – Translational and Torsional System (Newton's Second Law, D' Alembert's Principle, Rayleigh's Energy Method to be included) **Free Vibrations with Viscous Damping**: Derivation of Equation of Motion, Logarithmic Decrement, Energy Dissipated in Viscous Damping (Numerical on Translational and Torsional Systems to be included) **Free Vibration with Coulomb Damping:** Equation of Motion, Translational and Torsional Systems with Coulomb Damping	**09**
2	**Two-Degree-of-Freedom Systems** (**Undamped Systems):** Introduction, Mode Shapes, Analysis of Undamped Systems - Translational and Torsional Systems, using Newton's second law, and LaGrange's Equations **Multi Degree of Freedom System** (**Undamped Systems):** Introduction, Derivation of Equation of Motion of Systems using Newton's Second Law, Influence Coefficients, Equations in Matrix Form, Eigenvalue Problems, Determination of Natural Frequencies and Mode Shapes using Dunkerley's Formula, Rayleigh's Method, and Holzer's Method	**09**
3	**Harmonically Excited Vibration:** Introduction, Equations of Motion for Forced Vibrations, - Translational and Torsional Systems (including systems under support excitation, systems with rotary and reciprocating un balance).	**07**
4	**Vibration Measurement and Applications:** Working Principle of Vibration Measuring Instruments (Un-damped and damped) - Vibrometer, Accelerometer, and Velometer **Machine Condition Monitoring and Diagnosis:** Severity Criteria, Machine Maintenance, Monitoring Techniques (Time-Domain Analysis, Statistical Methods and Frequency Domain Analysis) Instrumentation Systems – FFT Analyzer, Choice of Monitoring Parameter, **Effects of Vibrations on environment, and society**: Sustainable Design, Ergonomic Design (Paper Review)	**09**
5	**Rotor Dynamics** - Single rotor systems - whirling of rotating shafts, critical speed of Damped & Undamped system, Multirotor systems – Analysis of Reciprocating & Rotating Unbalance (graphical approach) **Vibration Isolation**: Vibration Isolation System with Rigid Foundation, Flexible Foundation (including Partially Flexible Foundation), Vibration Isolation System with Base Motion, Shock Isolation, Active Vibration Control	**08**

List of Experiments (Recommended, but not limited to): Minimum eight experiments to be performed.
Note: Open-source software can be used as an alternative to licensed software like MATLAB

Syllabus for Third Year of B. Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Sr. No.	Title of Experiment
1	Experimental determination of natural frequency of compound pendulum and an equivalent simple pendulum system
2	Experimental determination of natural frequency of spring mass system under going longitudinal vibrations
3	Experimental determination of natural frequency of single rotor and two-rotor vibratory system
4	Experimental determination of damping coefficient of any system / media
5	Experimental balancing of multi-rotor system
6	Experimental measurement of vibration response of a system
7	Experimental verification of principle of Gyroscopic Couple
8	Study effects of vibrations using MEMS gyro model (MATLAB / Simulink)
9	Study characteristic behavior of SDOF system under going forced vibrations using MATLAB programming
10	Study of damped and un-damped vibrations using MATLAB
11	Study of forced vibrations USING MATLAB SIMULINK
12	Simulation based study of rotary un-balanced forces
13	Write a program in MATLAB simulating / analyzing behavior of simple or compound pendulum
14	Find MI of irregularly shaped solid body using trifilar suspension (Virtual Lab Simulation)
15	Write a Program in MATLAB simulating / analyzing behavior of simple or compound pendulum

Books Recommended:

Text books:

1. Mechanical Vibrations, S. S. Rao, 6th Edition, 2017, Pearson Education

Reference Books:

1. Mechanical Vibrations, G. K. Grover, Paper Back Edition, 2009, Nem Chand & Bros.
2. Fundamentals of Mechanical Vibration, S. Graham Kelly, 2nd edition (Hardcover), 2000, Tata McGraw Hill
3. Schaum's Outline of Theory and Problems of Mechanical Vibration, William W. Seto, McGraw Hill
4. Theory and Practice of Mechanical Vibrations, J. S. Rao, K. Gupta, 2nd edition, 1999, New Age International Publications

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

- Term work shall consist of minimum 8 experiments and 5 assignments. Assignments can be given in form of tutorials or programming exercises.

- Programming / simulation-based exercises using MATLAB, MATLAB – Simulink, PYTHON Programming, or any other programming tools can be incorporated as a part of assignments or lab work.

Research based assignment, such as mini project or paper writing with focus on ergonomic design, green technology can also be given as an assignment (recommended but not mandatory)

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: V</td></tr>
<tr><td colspan="8">Course: Industrial Electronics and Control</td><td colspan="3">Course Code: DJ19MEC504</td></tr>
<tr><td colspan="8">Course: Industrial Electronics and Control Laboratory</td><td colspan="3">Course Code: DJ19MEL504</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="4">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="4">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">50</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">2</td><td rowspan="2">--</td><td rowspan="2">4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Assignments</td></tr>
<tr><td>25</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of basic electronic devices like Diodes, BJT etc. and basic digital electronics.

Objectives:

1. To study power electronic switches and circuits and their applications
2. To familiarise Op amp and digital circuits and their applications
3. To acquaint with basics of microprocessor and microcontroller
4. To study concept of mathematical modelling of the control system
5. To acquaint with control system under different time domain

Outcomes:

On completion of the course, learner will be able to:

1. Illustrate construction, working principles and applications of power electronic switches
2. Identify rectifiers and inverters for dc and ac motor speed control
3. Develop circuits using OPAMP and timer IC555
4. Identify digital circuits for industrial applications
5. Design mathematical model of system/process for standard input responses
6. Analyze error and differentiate various types of control systems and time domain

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in Hours**
1	**Microprocessor and Microcontrollers:** Overview of generic microprocessor, architecture and functional block diagram, Comparison of microprocessor and microcontroller MSP430 architecture, assembly language programming, C compiler programming, basics of interfacing with external input / output devices (like reading external analog voltages, digital input output) Applications of microcontroller: Temperature measurement, Speed Measurement using Proximity Sensor, Piezoelectric Actuator Drive	**08**
2	**Motors:** Review and comparison of DC motors and AC induction motors, Basic principles of speed control of AC induction motor Basics of BLDC motor, Linear Actuator motor, Servo Motor Motor Specifications, suitability of each motor for various industrial applications, Selection and sizing of motors for different applications. Applications for pumps, conveyors, machine tools, Microcontroller based speed control for Induction Motor.	**08**
3	**Control System** Introduction to control systems, Classification of control system. Open loop and closed loop systems. Mathematical modelling of control systems, concept of transfer function, Block diagram algebra	**07**
4	**Stability Analysis** Control system design and analysis by Root Locus Method, Control system Design by Frequency response method, stability margin, Nyquist diagram, Bode diagram P, I and D control actions, P, PI, PD and PID control systems, Transient response: Percentage overshoot, Rise time, Delay time, Steady state error, PID tuning (manual), Zigler Method	**11**
5	**Discrete Control System PLC (Programming Logic Control) Theory:** Introduction to PLC, Architecture, Ladder Logic programming for different types of logic gates, Latching, Timers, Counter, Practical Examples of Ladder Programming	**08**

List of Laboratory Experiments: Minimum six from 1-9 and four from 10-14, in all minimum ten experiments need to be performed out of the list given below.

1. MOSFET / IGBT as a switch
2. Single phase Bridge inverter with rectifier load
3. OPAMP as integrator
4. Implementing study of gates and Logic Operations like, NOT, AND, OR
5. Realization of basic gates using universal gates
6. Light dimmer circuit using Diac-Triac
7. Speed control of DC motor
8. Speed control of induction motor
9. Simple microcontroller-based application like Temp Measurement/ Speed Measurement using Proximity Sensor/ Piezoelectric Actuator Drive
10. Microcontroller based speed control for Induction Motor
11. Experiments on feedback control systems and servomechanisms
12. System Identification of any one of the sensors.
13. Experiment on frequency response system identification
14. Experiment on transient state response of a control system.

Books Recommended:

Reference Books:

1. Power Electronics M.H. Rashid, Prentice-Hall of India
2. Power Electronics, P S Bhimbra
3. Power Electronics, Vedam Subramanyam, New Age International
4. Power Electronics, Ned Mohan, Undeland, Robbins, John Wiley Publication
5. Electronic Devices and Circuits, Robert Boylestad and Louis Nashelsky, Prentice-Hall
6. Industrial Electronics and Control by S K Bhattacharya, S Chatterjee, TTTI Chandigarh
7. Modern Digitals Electronic, Jain R P, Tata McGraw Hill 8. Digital principal and Application, Malvino and Leach, Tata McGraw Hill
8. Fundamentals of Microcontrollers and Embedded System, Ramesh Gaonkar, PENRAM 10. MSP430 Microcontroller Basics, John H. Davies, Newnes
9. Modem Control engineering: by KOgata, Prentice Hall
10. Control systems by DhaneshManik, Cengage Learning
11. Engineering Metrology and Measurementsby N V Raghavendra and L Krishnamurthy, Oxford University Press 8. Instrumentation and Control System, W. Bolton, Elsevie

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 6 experiments and 5 assignments.

The distribution of marks for term work shall be as follows:

1. Laboratory work (Performance of Experiments): 15 Marks
2. Journal Documentation (Write-up, Assignments: 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: V</td></tr>
<tr><td colspan="8">Course: Machine Tool Engineering</td><td colspan="3">Course Code: DJ19MEC5011</td></tr>
<tr><td colspan="8">Course:</td><td colspan="3">Course Code:</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of Engineering Drawing, Applied Physics, Manufacturing Processes, Advanced Manufacturing Processes.

Objectives:

1. To study tool engineering and tool economics.
2. To study concept and design aspect of press tool used for sheet metal forming.
3. To learn principle and design aspects of Jigs and Fixtures.

Outcomes: On completion of the course, learner will be able to:

1. Analyse various single and multipoint cutting tools with tool nomenclature as per standards and their design principles.
2. Analyse tool life and economics of machining.
3. Understand design principles of press tool components for piercing and blanking operation.
4. Illustrate design principles of press tool components in bending and drawing operation.
5. Understand appropriate combination of tools, jigs and fixture, suitable for a particular machining operation.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in Hours**
1	**Tool engineering:** Different systems of tool nomenclature like ASA, MRS, ORS and NRS, Interrelationship among different systems of nomenclature for tool angles, Constructional features of solid tool, tipped tools, mechanically held regrind able insert type tools and throw away tip type tools, Design principles of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders Design principles of Milling cutters, Broach tool and Forming Tool.	**12**
2	**Tool life and machining economics:** Definition, flank wear and crater wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, Effect of cutting parameters on tool life, Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate.	**04**
3	**Sheet metal forming operations:** **Piercing & blanking** Design principles of Press tool elements viz. Punches & methods of retaining punches, Die block, Stripper, Pilot, etc. Methods of reducing cutting loads on press tools, Different types Die sets and its selection.	**04**
4	**Bending and drawing** Theory of Bending, Spring back and measures to control it, Calculations for blank development of simple bent components, minimum bend radius, types of bending dies. Theory of Drawing, Metal flow in drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of cup. Defects in drawn as well as bent parts, Presses selection for drawing/forming operations. Basic construction and working of Bending and Drawing dies. **Miscellaneous dies-** Basic construction & working of Shaving dies, Trimming dies, Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies. Energy overloading and press safety devices.	**10**
5	**Jigs and Fixtures**: Need for Jigs and Fixtures, elements of Jigs and Fixtures, basic construction of Jig & Fixture, **Location & locating devices** Locating principles: degrees of freedom, redundant location, fool-proofing, nesting, Locators: locators that control work piece on flat surfaces, location of cylindrical surfaces, conical locators, centralizers. **Clamping & clamping devices** Requirement of clamping system, position of clamps, types of clamps, clamping devices; examples of typical clamps (multiple clamping and equalizing devices, quick acting clamping mechanisms such as link, toggle, cam, eccentric, pneumatic, hydraulic and electric devices), component distortion under clamping and cutting forces, Material used for different clamping devices of jigs/fixture and recommended hardness. **Construction of drill jig** Introduction, selection of location, supporting and clamping faces /points, cutting tools and means of guiding and supporting Jigs, various types of Jig bushes, **Construction of milling fixture** Introduction, Selection of location, supporting and clamping faces /points choice, tool setting block and Tennon. **Indexing jig & fixture** Introduction, application of indexing, Essential features of an indexing jig /fixture, Indexing devices.	**12**

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Books Recommended:

Text Book:
Tool Design by C. Donaldson and V. C. Goold, 4th edition (2012), Tata McGraw Hill Publications.

Reference Books:
1. Fundamentals of Modern Manufacturing, Mikell P Groover, 4th edition (2010), John Wiley & Sons.
2. Jigs and Fixtures, P H Joshi, 3rd edition (2010), Tata Mc Graw Hill.
3. Introduction to Jigs and Tool design, M. H. A. Kempster, 3rd edition, Butterworth Heinemann Ltd.
4. Processes and Materials of Manufacture, R A Lindberg, 4th edition, PHI.
5. Press Tools Design and Construction by P H Joshi, 4th Edition (1996), S. Chand Publishing.
6. Fundamentals of Metal Machining and Machine Tools, Geoffrey Boothroyd, Winston A. Knight, 3rd Edition (2006), CRC press Taylor and Francis group.
7. ASM Handbook, Vol. 16: Machining by Joseph R. Davis, 9th edition, ASM International.
8. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth, 2nd Edition (2003), New Age International
9. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow.
10. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow.

Evaluation Scheme:
Semester End Examination (A):
Theory:
1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):
Theory:
1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: V</td></tr>
<tr><td colspan="8">Course: Renewable Energy Systems</td><td colspan="3">Course Code: DJ19MEC5012</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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</table>

Pre-requisite: Knowledge of Energy science, Energy sources

Objectives:

1. To study working principles of various renewable energy sources and their utilities.
2. To study economics of harnessing energy from renewable energy sources.

Outcomes: On completion of the course, learner will be able to:

1. Explain the need of different renewable energy sources.
2. Discuss importance of renewable energy sources.
3. Discuss various renewable energy sources in Indian context.
4. Calculate and analyse utilization of solar and wind energy.
5. Illustrate design of biogas plant.
6. Explain basics of hydrogen energy.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in Hours**
1	**Introduction to Energy Sources:** Renewable and non-renewable energy sources, Need for Renewable Energy Sources, Energy Consumption as a measure of Nation's development; Strategy for meeting the future energy requirements, Global and National scenarios, Prospects of renewable energy sources, Present status and current installations, Introduction to Hybrid Energy Systems, various MNRE programmes.	**04**
2	**Solar Energy:** Merits and demerits, Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solar radiation, local solar time, derived solar Angles, sunrise, sunset and day length, Methods of Solar Radiation estimation. Solar Energy collection devices and Classification: Flat plate collectors, concentrating collectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond, solar water heaters, solar distillation, solar still, solar cooker, solar heating & cooling of buildings, Solar Photovoltaic systems & applications.	**12**
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis of Aerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection Considerations.	**10**
4	**Energy from Biomass:** Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of biogas, utilization of biogas. **Hydrogen Energy:** Methods of Hydrogen production, Hydrogen Storage, Fuel Cells and Types of Fuel Cells.	**08**
5	**Geothermal Energy:** Estimation and nature of geothermal energy, geothermal sources and Resources like hydrothermal, geo-pressured hot dry rock, magma. Advantages, disadvantages and Application of geothermal energy, prospects of geothermal energy in India. **Energy from the ocean:** Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.	**08**

Books Recommended:

Reference Books:

1. Non-conventional energy sources, G.D. Rai, 6th edition, 1988, Khanna Publishers.
2. Renewable Energy: Power for a Sustainable Future, Edited by Godfrey Boyle, 3rd Edition, 2012, Oxford University Press.
3. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme, J K Nayak, 4th edition, 2017, TMH.
4. Solar Energy: Fundamentals and Applications, H.P. Garg, Jai Prakash, 1st revised edition, 1997, TMH.
5. Wind Power Technology, Joshua Earnest, 2014, PHI Learning.
6. Renewable Energy Sources, J. W. Twidell, Anthony D. Weir, 1986, ELBS Pub.
7. Energy Conversion Systems, R. D. Begamudre, 1998, New Age International (P) Ltd., Publishers.
8. Solar Photovoltaics: Fundamentals, Technologies and Applications, C S Solanki, 3rd Edition, 2013, PHI Learning

9. Biomass Regenerable Energy, D. D. Hall and R. P. Grover, John Wiley, New York.
10. Wind and Solar Power Systems, Mukund R Patel, 2nd edition, 2005, CRC Press.
11. Wind Energy Explained: Theory, Design and Application, J F Manwell, J. C. McGowan, A. L. Rogers, John Wiley and Sons
12 Magneto Hydrodynamics, Kuliovsky, Lyubimov, 3rd edition, 2014, Addiso publishers.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for Third Year of B. Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: V</td></tr>
<tr><td colspan="8">Course: Quality Engineering</td><td colspan="3">Course Code: DJ19MEC5013</td></tr>
<tr><td colspan="8">Course:</td><td colspan="3">Course Code:</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
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<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Pre-requisite: Knowledge of Probability and Statistics.

Objectives:

1. Understand basic quality management principles.
2. Understand the relationship of the quality engineer to the quality system.
3. Analyse the relationship of statistics to a process.
4. Understand process capability and use statistical process control to monitor a process.
5. Generate acceptance sampling plans and identify and use technical quality tools.
6. Apply problem-solving tools and basic statistical concepts, process control and process capability plans, acceptance sampling, and attribute controls.

Outcomes: On completion of the course, learner will be able to:

1. Explain the importance of Quality for survival and growth of any business.
2. Prepare and interpret the control charts for variables and attributes.
3. Evaluate Process capability and determine tolerance limits.
4. Apply ANOVA test and determine the degree of relation between independent variables.
5. Elaborate significance of quality and application of Six Sigma in service sector

Syllabus for Third Year of B. Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in Hours**
1	**Introduction:** Different Definitions and Dimensions of Quality, Historical Perspective, Contribution of Renowned Quality Gurus, Total Quality Management Basic Philosophy, Approach, Barriers. **Mindset of Quality Improvements:** High quality of product and service and their associated customer satisfaction are the key to the survival and growth for any enterprises. Management culture advocating a total commitment to customer satisfaction through continuous improvement and innovation in all aspects of the business must be discussed in detail.	08
2	**Introduction to Control charts**, Construction and application. Chance and assignable causes of process variation, Statistical basis of the control chart for variable, Attribute control charts – p, n np, c and u charts. **Acceptance Sampling** Fundamental, OC Curves, Sampling Plans for Attributes, Signal and double sampling plans, Multiple and Sequential sampling plans, sampling plans for variables Demo on use of software like MS Excel, Minitab and JMP for control charts and acceptance sampling.	10
3	**Tolerance Design:** Process Capability Analysis, Process Capability Ratios, Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation for multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs.	08
4	**Introduction to Design of Experiments:** Introduction, Methods, Taguchi approach, Achieving robust design, Steps in experimental design. Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One way ANOVA, Two-way ANOVA, ANOVA for four level factors, multiple level factors. Introduction to t-test, f-test and hypothesis in connection with ANOVA. Demo on use of software like MS Excel, Minitab and JMP for DOE.	10
5	**Quality in Service Sectors:** Characteristics of Service Sectors, Quality Dimensions in Service Sectors, Measuring Quality in Different Service Sectors, Six sigma DMAIC methodology, and tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology.	06

Books Recommended:

Text books:

1. Introduction to Statistical Quality Control; D. C. Montgomery; Edition 6 ; 2009 ; John Wiley & Sons
2. Taguchi Methods explained: Practical steps to Robust Design; Tapan P. Bagchi; 1993; Prentice Hall Pvt. Ltd., New Delhi.
3. Managing for Total Quality; N. Logothetis; 1997; Prentice Hall of India

Reference Books:

1. Statistical Quality Control; Grant and Leavenworth; 1996; McGraw-Hill
2. Statistical Quality Design and Control; R.E. DeVor, T. Chang, J .W. Sutherland, 2007; Prentice Hall
3. Managing Quality; D.A. Garvin;1988; Free Press
4. Introduction to Quality Engineering; G. Taguchi; 1986; Asian productivity organisation
5. Poor Quality Cost; H.J. Harrington; 1987; Tayler and Francis
6. Quality Engineering Using Robust Design; M.S. Phadke;1989; Prentice Hall

7. Quality Control and Industrial Statistics; Acheson J. Duncan; Fifth Edition;1986; IRWIN
8. Quality Engineering off-line methods and applications; Chao-Ton Su; 2016; CRC Press Taylor & Francis Group.
9. Statistical Methods for Quality Assurance; Stephen B. Vardeman,J. Marcus Jobe; Second Edition ; 2016 ; Springer-Verlag

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="2">Semester: V</td></tr>
<tr><td colspan="8">Course: Python for Mechanical Engineering</td><td colspan="2">Course Code: DJ19MEL505</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="6">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
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<tr><td>--</td><td>--</td><td>25</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Objectives:

1. To understand the coding environment of Python Programming
2. To apply python coding skills for various Mechanical problems

Outcomes: On completion of the course, learner will be able to:

1. Understand the coding environment of Python software.
2. Understand the basics of Python
3. To read, analyse and visualize data.
4. To apply the python skills for Mechanical problems.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Python:** Python history, Introduction to Anaconda, Spyder IDE, how to go about programming, understanding of the layout of the programming environment and spyder.	**04**
2	**Basics of Python:** Assignment Statement, variable and datatypes, Loops, Strings, Lists, Operators, Arrays, Sorting, Functions and Dictionaries.	**07**
3	**Data Handling and Manipulation**: Reading Data, Introduction to Pandas Dataframe and Numpy, Data Visualization, exploratory Data Analysis.	**07**
4	**Using Python for Mechanical Applications (Design, Thermal and Manufacturing)**	**10**

List of Laboratory Experiments:

1. To take input from user and print the sum, smaller no, larger no.
2. At least two programs involving operations related to Basics of Python.
3. At least two programs related to Data handling and manipulation
4. Python applied to Mechanical Applications – At least 3

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Reference Books:

1. Problem Solving and Programming; S. Kuppuswamy, S. Malliga, C.S. Kanimozhi Selvi, K. Kousalya; 2019; Tata McGraw Hill.
2. Introducing Python Modern Computing in Simple Packages; Bill Lubanovic; 1st edition; 2014; O'Reilly Media
3. Python: The Complete Reference; Martin C; 1st edition; 2018; Tata MacGrawHill
4. Core Python Programming; R. Nageswara Rao; 2nd edition; 2018; DreamTech Press
5. Let Us Python; Yashavant Kanetkar; 2019; BPB Publication

Evaluation Scheme:

Semester End Examination (A):

Laboratory:

Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Laboratory: (Term work)

Term work shall consist of minimum 7 experiments, 1 Mini Project.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments: 10 marks)

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="7">Program: Third Year Mechanical Engineering</td><td colspan="4">Semester: V</td></tr>
<tr><td colspan="7">Course: Professional and Business Communication Laboratory</td><td colspan="4">Course Code: DJ19IHL2</td></tr>
<tr><td colspan="7">Course:</td><td colspan="4">Course Code:</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

*2 hrs. Theory (Class wise) and 2 hrs. Tutorial (Batch wise)

Pre-requisite:

Basic course in Effective Communication Skills

Objectives:

1. To inculcate professional and ethical attitude at the workplace
2. To enhance communication and interpersonal skills
3. To develop effective presentation skills
4. To hone written skills for technical documentation

Outcomes: On completion of the course, learner will be able to:

1. Plan, organize and write technical documents like reports, proposals and research papers in the prescribed format using appropriate language and style with an understanding of ethics in written communication
2. Apply techniques of writing resume, participating in a group discussion and facing interviews
3. Develop interpersonal skills in professional and personal situations
4. Understand the documentation process of meetings and conduct meetings in a professional manner
5. Understand communication across cultures and work ethics
6. Design and deliver effective presentations using Power Point

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in Hours**
	Unit 1: Technical Writing	
	Report Writing: Types of report, parts of formal report, collection of data and survey analysis, pre-writing of report, language and style in reports, formatting of reports, referencing in report **Proposal Writing: Types** of technical proposals, format of proposal, language and style, presentation of proposal **Technical Paper Writing:** Parts of a technical paper, language and formatting, referencing in IEEE format **Plagiarism:** Types of plagiarism, consequences of plagiarism	**08**
	Unit 2: Employment Skills	
	Group Discussion: Purpose of a GD, types of GD, criteria for evaluating a GD, Dos and Don'ts of a GD, Tips to be successful in GD **Cover Letter & Resume Writing:** Format and content of cover letter, types of resume, structure, content and formatting of resume **Interview Skills:** Types and modes of interview, Preparation for interview, Dos and Don'ts of interview, frequently asked questions during interview	**06**
	Unit 3: Introduction to Interpersonal Skills	
	Emotional Intelligence: Definition, difference between IQ and EQ, how to develop EQ **Leadership:** Types of leadership, leadership styles, case studies **Team Building:** Difference between group and team, importance of team work, strategies to be a good team player **Time Management:** Importance of time management, cultural views of time, 80/20 rule, time wasters, setting priorities and goals, **Conflict Management:** Types of conflicts, strategies to manage conflict, case studies	**05**
	Unit 4: Meetings and Documentation	
	Planning and preparation for meetings, strategies for conducting effective meetings, notice, agenda and minutes of a meeting, business meeting etiquettes	**02**
	Unit 5: Cross-cultural communication and Ethics	
	Communication across cultures, professional and work ethics, responsible use of social media, introduction to Intellectual Property Rights	**03**
	Unit 6: Presentation Skills	
	Presentation strategies, overcoming stage fear, techniques to prepare effective PowerPoint presentation	**02**

List of Assignments

1. Business Proposal (PowerPoint presentation)
2. Resume writing
3. Interpersonal Skills (documentation of activity)
4. Meetings and Documentation (Notice, Agenda, Minutes of Mock Meetings)
5. Business ethics
6. Presentation Skills

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

Books Recommended:

Reference Books:

1. Fred Luthans, "Organizational Behavior", McGraw Hill, edition
2. Lesiker and Petit, "Report Writing for Business", McGraw Hill, edition
3. Huckin and Olsen, "Technical Writing and Professional Communication", McGraw Hill
4. Wallace and Masters, "Personal Development for Life and Work", Thomson Learning, 12th edition
5. Heta Murphy, "Effective Business Communication", Mc Graw Hill, edition
6. Sharma R.C. and Krishna Mohan, "Business Correspondence and Report Writing", Tata McGraw-Hill Education
7. Ghosh, B. N., "Managing Soft Skills for Personality Development", Tata McGraw Hill. Lehman,
8. Bell, Smith, "Management Communication" Wiley India Edition, 3rd edition.
9. Dr. Alex, K.," Soft Skills", S Chand and Company
10. Subramaniam, R., "Professional Ethics" Oxford University Press.

Evaluation Scheme:

Laboratory: (Term work)

Term work shall consist of 6 assignments, Group Discussion and Power Point Presentation based on the written report

The distribution of marks for term work shall be as follows:

Assignments …… (25) Marks
Project Report and Presentation…… (15) Marks
Group Discussion……. (10) Marks
TOTAL: ……... (50) Marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester V (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: V</td></tr>
<tr><td colspan="8">Course: Innovative Product Development III</td><td colspan="3">Course Code: DJ19ILL1</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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</table>

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value-added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product.

Outcome:

Learner will be able to:

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyse the impact of the proposed method of design and development of the product.
5. Develop interpersonal skills, while working as a member of the team or as the leader.
6. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
7. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

Guidelines for Assessment of the work:

1. The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
2. In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.

3. Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:
   A. Marks awarded by the supervisor based on log-book :20
   B. Marks awarded by review committee: 20
   C. Quality of the write-up: 10

Review/progress monitoring committee may consider the following points during the assessment.

In the semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.

- First shall be for finalization of the product selected.
- Second shall be on finalization of the proposed design of the product.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

The semester V reviews may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:

- The write-up should be prepared as per the guidelines given by the department.
- The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester VI. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course : Machine Design I</td><td colspan="3">Course Code: DJ19MEC601</td></tr>
<tr><td colspan="8">Course : Machine Design I Laboratory</td><td colspan="3">Course Code: DJ19MEL601</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
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<tr><td>25</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Strength of Materials
2. Material Technology

Objectives:

1. To familiarize with use of design data books & various design codes of practices
2. To study basic principles of machine design
3. To acquaint with the concepts of design based on strength & rigidity

Outcomes: On completion of the course, learner will be able to:

1. Use design data books in designing various components.
2. Illustrate basic principles of machine design.
3. Demonstrate understanding of various design considerations, theories of failures, Standards/Codes.
4. Design machine elements for static as well as dynamic loading.
5. Design machine elements on the basis of strength/ rigidity concepts.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in hours**
1	**Introduction to Machine Design:** Mechanical Engineering Design, Design methods, Aesthetic and Ergonomics consideration in design, Material properties and their uses in design, Manufacturing consideration in design, Design consideration of casting and forging **Basic Principle of Machine Design:** Modes of failures, Factor of safety, Design stresses, Guidelines for selection of Theories of failures in the process of designing, Standards, I.S. Codes, Preferred Series and Numbers.	**6**
2	**Design against Static Loads:** Cotter joint, Knuckle joint, Turn buckle, Bolted and welded joints under eccentric loading; **Curved Beams:** Assumptions made in the analysis of curved beams, Design of curved beams: Bending stresses in curved beams such as crane hook, C-frame, etc. **Power Screw** –C-clamps along with the Frame, Screw Jack	**16**
3	**Design against Fluctuating Loads:** Variable stresses - reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit-estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, Fatigue design under combined stresses	**05**
4	**Design of Shaft:** power transmitting and power distribution shafts (excluding crank shaft) under static and fatigue loading **Keys**: Types of Keys and their selection based on shafting condition **Couplings:** Classification of coupling, Design of Flange couplings, Bush pin type flexible couplings	**08**
5	**Design of Springs:** Design of helical compression and tension Springs under Static and Variable loads, design of Leaf springs **Design of Thin Cylindrical and Spherical Shells:** Design of Cylinders, Cylindrical shell with hemi spherical ends and Spheres	**07**

List of Design exercises /Assignments /Sheets:

Part (A).Following assignments are to be solved in the lab sessions in the form of tutorial or any software based exercises (Minimum six):

1. Design of Curved Beams
2. Design of Cotter Joint
3. Design of Knuckle Joint
4. Design of C-clamp along with frame
5. Design of Screw jack
6. Design of Bolted and welded joints
7. Design under fluctuating loads (finite and infinite life)
8. Design of Shaft
9. Design of Coupling
10. Design of Leaf spring
11. Design of Helical Spring

Part (B) Prepare a layout of following using any CAD software (Minimum two):

1. Layout of Cotter Joint
2. Layout of Knuckle Joint
3. Layout of C-clamp
4. Layout of Screw jack

5. Layout of coupling
6. Layout of Leaf spring

Books Recommended:

Text books:

1. Mechanical Engineering Design by J.E.Shigley, McGraw Hill
2. Design of Machine Elements - V.B. Banadari, Tata McGraw Hill Publication
3. Design of Machine Elements - Sharma, Purohil. Prentice Hall India Publication

Reference Books:

1. Design of Machine Elements by V.M.Faires
2. Design of Machine Elements by Spotts.
3. Machine Design by R.C.Patel, Pandya, Sikh, Vol-I & II C. Jamnadas & Co
4. Machine Design by Black Adams, McGraw Hill
5. Design Data book by P.S.G. College of Technology, Coimbatore.
6. Design Data Book- Mahadevan.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of Part (A) and Part (B).

The distribution of marks for term work shall be as follows:

i. Part (A): 15 Marks
ii. Part (B): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: VI</td></tr>
<tr><td colspan="8">Course: Refrigeration and Air Conditioning</td><td colspan="3">Course Code: DJ19MEC602</td></tr>
<tr><td colspan="8">Course: Refrigeration and Air Conditioning Laboratory</td><td colspan="3">Course Code: DJ19MEL602</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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</table>

Pre-requisite: Knowledge of thermodynamics, heat transfer and fluid mechanics.

Objectives:

1. To apply the thermodynamic principles to refrigeration and air-conditioning systems.
2. To analyse and compare the performance of different refrigeration and air-conditioning systems.
3. To study the controls and applications of refrigeration and air-conditioning systems.

Outcomes: On completion of the course, learner will be able to:

1. Apply the fundamentals of thermodynamics to refrigeration systems and calculate the coefficient of performance of reversed Carnot cycle, Bell-Coleman cycle and Aircraft refrigeration systems.
2. Analyse the vapour compression refrigeration systems, components and interpret the importance of refrigerant properties and its selection criteria.
3. Analyse the psychrometric properties, processes, charts and principles of air-conditioning.
4. Design air-conditioning systems using cooling load calculations and duct design principles.
5. Discuss the applications and controls of various refrigeration and air-conditioning systems.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (Unit wise)

Unit	Description	Duration in hours
1	**Introduction to Refrigeration:** Methods of refrigeration, First and Second Law applied to refrigerating machines, Carnot refrigerator & Carnot heat pump. Unit of refrigeration, Co-efficient of Performance, Energy Efficiency Ratio (EER) and BEE star rating. Air refrigeration systems: Bell Coleman cycle, analysis and applications. Aircraft refrigeration systems: Simple, Bootstrap, Reduced ambient & Regenerative aircraft cooling system, Importance of Dry Air Rated Temperature.	**08**
2	**Vapour Compression Refrigeration Systems:** Simple vapour compression cycle, Effect of liquid sub cooling & superheating, effect of evaporator and condenser pressures, methods of sub-cooling, Use of P-h charts, Actual VCR cycle, 2 stage VCR systems & applications. Types of Compressors, Condensers, Expansion devices and Evaporators. **Cooling tower:** Types of cooling towers, tower approach, tower range, tower efficiency, tower losses, tower maintenance. **Refrigerants:** Desirable properties of refrigerants, ASHRAE numbering system for refrigerants, Secondary refrigerants, ODP and GWP, Montreal & Kyoto protocol and India's commitment & Recent developments in refrigerants. **Non-Conventional Refrigeration Systems:** Ammonia-water & Lithium Bromide–Water vapour absorption refrigeration system, Thermoelectric refrigeration, Thermo-acoustic refrigeration, Vortex tube refrigeration systems & Radiant heating and cooling systems.	**12**
3	**Psychrometry:** Need for air conditioning, Principle of psychrometry, Psychrometric properties, chart and processes, Bypass factor, Sensible heat factor, Adiabatic mixing of two air streams, Air washers, Requirements of comfort air conditioning, Summer and Winter Air conditioning.	**06**
4	**Design of Air Conditioning Systems:** Different Heat sources, Cooling Load estimation, Ventilation and infiltration, Inside and Outside Design condition, RSHF, GSHF, ERSHF, Room apparatus dew point and coil apparatus dew point. Introduction to Unitary Products: Room/Split and Packaged Air Conditioners, Introduction to recent developments: VRF systems, VAV systems, Inverter Units. Human Comfort, Thermal exchange of body with environment, Effective temperature, Comfort chart, Comfort zone, Indoor Air Quality, Green Buildings. **Duct Design:** Friction chart for circular ducts, Equivalent diameter of a circular duct for rectangular ducts, Methods of duct design, Factors considered in air distribution system, Air distribution systems for cooling and heating.	**12**
5	**Controls and Applications:** Controls: LP/HP cut-off, Thermostats, Humidistats, Interlocking control, Electronic Controllers. Applications: Refrigeration & A/C Ice plant – food storage plants – dairy and food processing plants, Food preservation, Freeze Drying, A/C in textile industry, printing, pharmaceutical industry and Hospitals & Deep sea water air-conditioning.	**04**

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

List of Laboratory Experiments: (Any six)

1. Trial on Refrigeration test rig.
2. Trial on Air conditioning test rig.
3. Study of domestic refrigerator along with wiring diagram.
4. Study of leak detection, evacuation and charging of refrigerant.
5. Report on different protocols to regulate global warming.
6. Simulation of VCR system with an open-source software.
7. Cooling load estimation exercise for an actual scenario.
8. Visit report of a manufacturing unit of refrigerator/air-conditioner or a cold storage plant/ice plant.

Books Recommended:

Text books:

1. Refrigeration and air-conditioning – C. P. Arora, 3rd Edition, 2017, McGraw Hill
2. Refrigeration and air-conditioning – Domkundwar, Arora, 2018, Dhanpat Rai
3. Basic Refrigeration and air-conditioning- P. Ananthanarayana, TMH
4. Refrigeration and air-conditioning – R K Rajput, 3rd Edition, 2013, S.K. Kataria & Sons
5. Refrigeration and air-conditioning – Manohar Prasad, 3rd Edition, 2015, New Age Publisher

Reference Books:

1. Principles of refrigeration – R J Dossat, Willey Eastern Publication
2. Refrigeration and air-conditioning – W F Stoeker and J W Jones, TMH
3. Air Conditioning System Design – Roger Legg, Butterworth-Heinemann Publication
4. ASHRAE Handbook of Fundamentals
5. ISHRAE Refrigeration Handbook
6. ISHRAE Air Conditioning Handbook

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which. Total duration allotted for writing each of the paper is 1 hr.
2. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 5 experiments and minimum 2 assignments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks

ii. Journal Documentation (Write-up and Assignments): 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course: Mechatronics</td><td colspan="3">Course Code: DJ19MEC603</td></tr>
<tr><td colspan="8">Course: Mechatronics Laboratory</td><td colspan="3">Course Code: DJ19MEL603</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="3">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="3">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">50</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">2</td><td rowspan="2">--</td><td rowspan="2">4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Assignments</td></tr>
<tr><td>25</td><td>--</td><td>--</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Objectives:

1. To study key elements of Mechatronics system and its integration
2. To familiarise concepts of sensors characterization and its interfacing with microcontrollers
3. To study continuous control logics i.e. P, PI, PD and PID
4. To study discrete control logics in PLC systems and its industrial applications.
5. To Design Pneumatic and Hydraulic Circuits

Outcomes:

At the end of the course the student will be able to...

1. Represent Mechatronics system with block diagrams
2. Identify the suitable sensor and actuator for a given mechatronics system
3. Distinguish and analyse various circuits for signal conditioning and their interfacing with microcontrollers
4. Design hydraulic/pneumatic circuits
5. Analyse continuous control logics (P, PI, PD and PID) for standard input conditions
6. Develop ladder logic programming

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Sr. No.	**Details**	**Duration in hours**
1	**Introduction of Mechatronics and automation** Key elements of mechatronics and automation, Applications of Mechatronics domestic, industrial etc. **Levels of automation** Automation principles and strategies: ten strategies of automation and production system, automation migration strategy **Advanced automation functions:** safety, maintenance & repair diagnosis, error detection and recovery	**06**
2	**Sensors and actuators** **Sensors:** Criteria for selection of sensors based on requirements, principle of measurement, sensing method, performance chart etc. (Displacement, temperature, acceleration, force/pressure) based on static and dynamic characteristics. **Actuators:** Selection of actuators based on principle of operation, performance characteristics, maximum loading conditions, safety etc. Principle and selection of mechano-electrical actuators (1) DC motors (2) Stepper Motors (3) Solenoid Actuators (4) Servo Motors (5) BLDC	**06**
3	**Mechanization, Automation and Interfacing:** Mechanization and automation, product cycle, hard Vs flexible automation, Capital- intensive Vs low-cost automation Types of systems-mechanical, electrical, hydraulic, pneumatic and hybrid systems Automation using CAMS, Geneva mechanisms, gears etc. Assembly line Automation: automated assembly systems, transfer systems, vibratory bowl feeders, non-vibratory feeders, part orienting, feed track, part placing & part escapement systems Introduction to Material storage/ handling and transport systems, and its automation using AS/RS, AGVS and conveyors etc. **Interfacing:** Interfacing of 8051 with Different types of Motors.	**08**
4	**Pneumatic and Hydraulic Circuits** Hydraulic and pneumatic devices-Different types of valves, Actuators and auxiliary elements in Pneumatics & hydraulics, their applications and use of their ISO symbols Synthesis and design of circuits (up to 3 cylinders)–pneumatic, electro pneumatics and hydraulics Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping	**10**
5	**Introduction to Robotics, IoT and Artificial Intelligence:** Automation and Robotics, Robot types, anatomy and related attributes, accuracy, repeatability Trajectory planning, Robot control system and end effector, Sensors in robotics, Industrial application and future applications, Introduction to IoT Introduction to Artificial Intelligence.	**12**

List of Laboratory Experiments:

1. Study Behaviour of Inductive sensors
2. Study Behaviour of Capacitive sensors
3. Writing a PLC ladder Program for give task -1
4. Pneumatic circuit sequencing
5. Electro-pneumatic circuit sequencing
6. Study Manual Direction Control valve

7. Direct control of double acting cylinder

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Reference Books:

1. Mechatronics, Kenji Uchino and Jayne R. Giniewicz, publication: Marcel Dekker, Inc
2. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
3. Mechatronics System Design, Shetty and Kolk, Cengage Learning, India Edition
4. Introduction to Mechatronics and Measurement Systems, Alciatore and Histand, Tata McGraw-Hill
5. Mechatronics, Necsulescu, Pearson education
6. Mechatronics - Electromechanics and Control Mechanics, Mill Springer-Verlag
7. Mechatronics - Electronic Control Systems in Mechanical Engineering, Bolton Pearson education
8. Mechatronics - Electronics in products and processes, Bradley, et al. Chapman and Hall
9. Mechatronics - Mechanical System Interfacing, Auslander and Kempf, Prentice Hall
10. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
11. Pneumatic Circuits and Low-Cost Automation by Fawcett JR
12. The Art of Electronics, Horowitz and Hill Cambridge, University Press
13. Electromechanical Design Handbook, Walsh, McGraw-Hill
14. Electro-mechanical Engineering - An Integrated Approach, Fraser and Milne

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 6 experiments and 5 assignments.

The distribution of marks for term work shall be as follows:

1. Laboratory work (Performance of Experiments): 15 Marks

2. Journal Documentation (Mini Proj/Write-up, Assignments: 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course : Power Engineering</td><td colspan="3">Course Code: DJ19MEC604</td></tr>
<tr><td colspan="8">Course: Power Engineering Laboratory</td><td colspan="3">Course Code: DJ19MEL604</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
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</table>

Pre-requisite: Knowledge of Thermodynamics and Fluid Mechanics

Objectives:

1. To study boilers, boiler mountings and accessories
2. To study steam turbines, hydraulic turbines and their utilities
3. To study pumps, compressors and their utilities

Outcomes: On completion of the course, learner will be able to:

1. Understand working of different types of boilers and analyze steam generator, steam turbine performance.
2. Explain basic concepts in the case of centrifugal compressors and analyze their performance.
3. Describe working of axial flow compressors and analyze their performance.
4. Explain basic difference between impulse and reaction water turbines, determine various parameters and design turbine runners.
5. Describe operating principles of reciprocating and centrifugal pumps and evaluate their performance.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (Unit wise)		
Unit	**Description**	**Duration in Hours**
1	**Steam Generators** Fire tube and Water tube boiler, Low pressure and high-pressure boilers, once through boiler, examples, and important features of HP boilers, Mountings and accessories, Equivalent evaporation of boilers, Boiler performance, Boiler efficiency. **Steam Nozzle** Flow through steam nozzle-velocity at exit and condition for maximum discharge, nozzle efficiency. **Steam Turbine-** Basic of steam turbine, Classification, compounding of turbine, Impulse turbine – velocity diagram, Condition for max efficiency, Reaction turbine - velocity diagram, degree of reaction, Parson's turbine, Condition for maximum efficiency.	**10**
2	**Rotary Compressors:** vane type compressors, scroll & screw compressors etc. **Centrifugal compressors**; Work required, polytropic efficiency, pressure rise, slip, effect of blade shape, two-dimensional flow through impeller; Vaned diffuser and volute casing; Surging and choking of compressors; Compressor performance and characteristic curves.	**05**
3	**Axial flow compressors;** Cascade analysis, vortex theory, work required, polytropic efficiency, pressure rise, degree of reaction; Simple design calculations; Surging and stalling of compressors; Compressor performance and characteristic curves.	**05**
4	**Hydraulic Turbines:** Introduction to hydrodynamic thrust of jet on a fixed and moving surface (flat & curve), Types of hydro turbines - impulse and reaction, definition of various turbine parameters like gross head, discharge, work done, input power, output power, efficiencies etc., Eulers' equation applied to a turbine, turbine velocities and velocity triangles, expression for work done. **Impulse Turbine:** Components of Pelton turbine, definition of design parameters like speed ratio, jet ratio, and estimation of various parameters like head, discharge, and efficiency etc., determination of number of buckets. **Reaction Turbines:** Types of reaction turbines - inward and outward flow, Francis turbine, Kaplan turbine; elements of the turbine, estimation of various parameters. Unit quantities in turbines.	**10**
5	**Pumps** Classification of pumps: positive displacement and non - positive displacement **Positive Displacement pumps:** Types and applications, general features of rotary pumps, general feature of reciprocating pumps, definition of head, discharge, work done and efficiency, types of reciprocating pumps, indicator diagram, use of air vessel. **Centrifugal Pumps:** Types - radial flow, mixed flow and axial flow, priming of pumps, components of the pump, Euler's equation and velocity triangles, correction factors for the head, design constant e.g., head constant, flow constant etc. self-priming pumps, series and parallel operation of pumps, system curve, determination of operating point, Cavitation in pumps, Determination of available and required NPSH, Model testing, Dimensional analysis. **Submersible Pumps:** Types and applications, general features of submersible pumps, work done and efficiency	**12**

List of Laboratory Experiments: (Any six)

1. Study/Demonstration of Boilers
2. Study/Demonstration of Boiler mountings and accessories
3. Study of Steam Turbine
4. Trial on Impulse turbine (Pelton Wheel)
5. Trial on Reaction water turbine (Francis / Kaplan turbine)
6. Study of Rotary compressors
7. Trial on Positive displacement pump
8. Trial on Single stage centrifugal pump
9. Trial on Multistage centrifugal pump
10. Demonstration of different components of Centrifugal pump by dismantling the pump system.

Books Recommended:

Reference Books:

1. Thermal Engineering, R K. Rajput, 10th edition, Laxmi Publication
2. Thermal Engineering, Kothandraman, Domkundwar, Khajuria, Arora, 5th edition, 2002, Dhanpatrai & Sons
3. Thermal Engineering, Ballaney P.L., 25th edition, 2015, Khanna Publishers.
4. Steam & Gas Turbines and Power Plant Engineering, R. Yadav, 7th edition, 2000, Central Publishing house Allahabad
5. Fluid Mechanics and Fluid Machines, D.S. Kumar, 2013, S.K. Kataria & Sons
6. Fluid Mechanics and Machinery, C. S. P. Ojha, P. N. Chandramouli, R. Berndtsson, 2010, Oxford University Press
7. Fluid Mechanics and Hydraulic Machinery, P. N. Modi and S. M. Seth, 17th edition, 2011, Standard Book House.
8. Hydraulic Machines Including Fluidics, Jagdish Lal, 6th edition, 2016, Metropolitan Book Company pvt. Ltd.
9. Theory and Design of Hydraulic Machines Including Basic Fluid Mechanics, Vasandani V.P., Khanna Publishers.
10. Hydraulic Machines, R K Rajput, S.Chand Publication.
11. Fluid Mechanics and Fluid Machines, Bansal R.K, 9th edition, 2015, Laxmi Publications.
12. Turbines, Fans and Compressors; Yahya S.M, 4th edition, 2011, Tata McGraw Hill.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which one can be assignment. Total duration allotted for writing each of the paper is 1 hr.
2. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Term work shall consist of minimum 06 experiments, minimum 05 assignments covering numerical.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Write-up and Assignments): 10 marks

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: VI</td></tr>
<tr><td colspan="8">Course: Smart Materials</td><td colspan="3">Course Code: DJMEC6011</td></tr>
<tr><td colspan="8">Course:</td><td colspan="3">Course Code:</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
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</table>

Pre-requisite: Knowledge of

1. Material Technology

Objectives:

1. To study the working principles of various smart materials.
2. To identify applicability of various smart materials as actuator and sensor.
3. To study advances in smart materials

Outcomes: On completion of the course, learner will be able to:

1. Understand working of smart materials and their application as actuator and sensor.
2. Select an appropriate smart material for a given application.
3. Identify applicability of smart materials for new prospective smart structures

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in hours**
1	Introduction to Smart Materials: Overview of the different types of Smart Materials, Smart materials used in structures, smart material for sensors, actuators controls, memory and energy storage and their inter-relationships, concept of High bandwidth- low strain generating materials (HBLS), and Low Bandwidth High Strain Generating Materials (LBHS)	**8**
2	Overview of the following materials with focus on synthesis, constitutive/governing relationships, strengths and weaknesses, and applications (both sensing and actuation etc) 1. Peizoelectric Materials 2. Magnetostrictive Materials 3. Shape Memory Alloys 4. Electroactive Polymers	**9**
3	Overview of the following materials with focus on synthesis, strengths and weaknesses, and applications 1. Ferrofluids and Magneto rheological Fluids and applications in dampers 2. Soft Matter and its applications as smart skins, smart textiles etc 3. Carbon Nanotubes and Carbon nano-structures and its applications 4. Thermoelectric Materials and Peltier devices	**9**
4	Smart Materials for Energy Applications: Materials used for energy storage, Hydrogen Storage Materials, Energy harvesting, Energy scavenging from vibrations	**8**
5	Composite Materials: Introduction to Composite Materials, Nano Composite Materials, Soft conducting and magnetic solids, active fiber composites, Smart polymer matrix composites	**8**

Books Recommended:

Reference Books:

1. Shape Memory Alloys; D.C. Lagoudas; 2008; Springer Science.
2. Self-healing Materials: Fundamentals, Design Strategies and Applications; S.K. Ghosh; 2009; Wiley-VCH Verlag GmbH and Co.
3. Energy Harvesting Technologies; S Priya and D J Inman; 2008; Springer-Verlag.
4. Optical Materials and Applications; Moriaki Wakaki; 2012; CRC Press.
5. Polymer Nano-composites and their Applications; S.S. Ray, M Bousmina; 2008; American Scientific Publishers.
6. Smart Materials and Structures; M.V. Gandhi and B.S. Thompson; 1992; Chapman & Hall, London; New York.
7. Encyclopedia of Smart Materials Vol. I and II; Mel Scwartz; 2002; John Wiley & Sons.
8. Smart Structures: Analysis and Design; A.V. Srinivasan; 2001; Cambridge University Press, Cambridge; New York.
9. Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers; G. Gautschi; 2002; Springer, Berlin; New York.
10. Piezoelectric Actuators and Ultrasonic Motors; K. Uchino; 1997; Kluwer Academic Publishers, Boston.
11. Handbook of Giant Magnetostrictive Materials; G. Engdahl; 2000; Academic Press, San Diego, Calif.;London.
12. Shape Memory Materials; K. Otsuka and C.M. Wayman; 1998; Cambridge University Press, Cambridge; New York.
13. Fiber Optic Sensors: An Introduction for Engineers and Scientists; Eric Udd; 1991; John Wiley & Sons, New York.
14. Electroactive Polymers for Robotic Applications: Artificial Muscles and Sensors; Kwang J KIm and Satoshi Tadokore; 2007; Springer-Verlag, London.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester : VI</td></tr>
<tr><td colspan="8">Course: Design of Heat Exchanger Equipment</td><td colspan="3">Course Code: DJ19MEC6012</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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</table>

Pre-requisite: Knowledge of Heat Exchangers and Heat Transfer.

Objectives:

1. To understand the factors influencing the design of Heat Exchanger
2. To design the various parts of a Heat Exchanger

Outcomes: On completion of the course, learner will be able to:

1. Classify different HX and understand the methodologies for its design.
2. Design double pipe HX
3. Design SHTX
4. Design Compact HX
5. Understand the heat transfer enhancement techniques and performance evaluation.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in hours**
1	**Different classification and basic design methodologies for heat exchanger:** Classification of heat exchanger, selection of heat exchanger, overall heat transfer coefficient, LMTD method for heat exchanger analysis for parallel, counter, multi-pass and cross flow heat exchanger, e-NTU method for heat exchanger analysis, fouling, cleanliness factor, percent over surface, techniques to control fouling, additives, rating and sizing problems, heat exchanger design methodology	**10**
2	**Design of double pipe heat exchangers:** Thermal and hydraulic design of inner tube and annulus, hairpin heat exchanger with bare and finned inner tube, total pressure drop	**08**
3	**Design of Shell & tube heat exchangers:** Basic components, basic design procedure of heat exchanger, TEMA code, J-factors, conventional design methods, Bell-Delaware method.	**10**
4	**Design of compact heat exchangers:** Heat transfer enhancement, plate fin heat exchanger, tube fin heat exchanger, heat transfer and pressure drop	**08**
5	**Heat Transfer Enhancement and Performance Evaluation:** Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis.	**06**

Books Recommended:

Reference Books:

1. Heat Exchangers; Sadik Kakaç, Hongtan Liu, Anchasa Pramuanjaroenkij; 4th Edition; 2020; CRC Press
2. Compact Heat Exchangers; Kays, V.A. and London, A.L; Third Edition; 1998; Mc Graw Hill.
3. Fundamentals of Heat Exchanger Design; Ramesh K Shah, Dusan P. Sekulic;2003; Wiley Publication
4. Process Heat transfer; D Q Kern; 2nd Edition; 2019; Tata Mc Graw Hill

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester :VI</td></tr>
<tr><td colspan="8">Course : Reliability Engineering</td><td colspan="3">Course Code:
DJ19MEC6013</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
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<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
</table>

Pre-requisite: Knowledge of Probability.

Objectives:

1. To familiarize the students with various aspects of probability theory.
2. To acquaint the students with reliability and its concepts.
3. To introduce the students to methods of estimating the system reliability of simple and complex systems.
4. To understand the various aspects of Maintainability, Availability and FMEA procedure.

Outcomes: On completion of the course, learner will be able to:

1. Apply the laws of Probability to engineering problems.
2. Analyze failure data and apply various reliability concepts to calculate different reliability parameters.
3. Evaluate the system reliability of simple and complex systems.
4. Apply redundancy techniques to improve the system Reliability.
5. Apply a Failure Mode Effect and Criticality Analysis, Fault tree analysis and Event tree analysis to analyze complex systems.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in hours**
1	**Probability theory:** Probability: Standard definitions and concepts; Conditional Probability, Bayes' Theorem. **Probability Distributions:** Binomial, Normal, Poisson, Weibull, Exponential, relations between them and their significance. **Measures of Central tendency and Dispersion:** Mean, Median, Mode, Range, Mean Deviation, Standard Deviation, Variance, Skewness and Kurtosis.	**09**
2	**Reliability Concepts:** Reliability definitions, Importance of Reliability, Quality Assurance and Reliability, Bath Tub Curve. **Failure Data Analysis**: Hazard rate, failure density, Failure Rate, Mean Time To Failure (MTTF), MTBF, Reliability Functions. **Reliability Hazard Models**: Constant Failure Rate, Linearly increasing and decreasing Failure rate, Time Dependent Failure Rate, Weibull Model. Distribution functions and reliability analysis.	**09**
3	**System Reliability:** System Configurations: Series, parallel, mixed configuration, k out of n structure, Complex systems.	**06**
4	**Reliability Improvement:** Redundancy Techniques: Element redundancy, Unit redundancy, Standby redundancies. Markov analysis. **System Reliability Analysis** – Enumeration method, Cut-set method, Success Path method, Decomposition method.	**10**
5	**Maintainability and Availability:** System downtime, Design for Maintainability: Maintenance requirements, Design methods: Fault Isolation and self-diagnostics, Parts standardization and Interchangeability, Modularization and Accessibility, Repair Vs Replacement. Availability – qualitative aspects. **Failure Mode, Effects and Criticality Analysis:** Failure mode effects analysis, severity/criticality analysis, FMECA examples. Fault tree construction, basic symbols, development of functional reliability block diagram, Fau1t tree analysis and Event tree Analysis. Case studies on Fault tree/event tree analysis.	**08**

Books Recommended:

Text books:

1. Reliability Engineering; L.S. Srinath; 4th edition; 2008; Affiliated East-West Press (P) Ltd.
2. Reliability Engineering; E Balagurusamy; 2017; Tata McGraw-Hill.

Reference Books:

1. Engineering Reliability; B.S. Dhillion, C. Singh; 1981; John Wiley & Sons.
2. Reliability and Maintainability Engineering; Charles E. Ebeling; 2007; Tata McGraw Hill.
3. Practical Reliability Engineering; P.D.T. Connor, A Kleyner; 5th edition; 2012; John Wiley & Sons.
4. Reliability in Engineering Design; K.C. Kapur, L.R. Lamberson; 2009; John Wiley & Sons.
5. Probability and Statistics; Murray R. Spiegel; 3rd edition; 2010; Tata McGraw-Hill.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: VI</td></tr>
<tr><td colspan="8">Course: Database Management System Laboratory</td><td colspan="3">Course Code: DJ19MEL605</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="5">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="5">--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td colspan="5">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">50</td></tr>
<tr><td rowspan="2">--</td><td rowspan="2">2</td><td rowspan="2">--</td><td rowspan="2">1</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>--</td><td>--</td><td>25</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Objectives:

1. Learn and practice data modeling using the entity-relationship (ER) and developing database designs.
2. Understand the use of Structured Query Language (SQL) and learn SQL syntax.
3. Understand the need of database processing and learn techniques for controlling the consequences of concurrent data access.

Outcomes: On completion of the course, learner will be able to:

1. Understand the fundamentals of a database system and design an optimized database.
2. Design and draw ER and EER diagram for the real-life problem.
3. Create and populate a Relational Database and retrieve any type of information from the database by formulating SQL queries.
4. Analyze and apply concepts of normalization to relational database design.
5. Understand the concept of transaction, concurrency and recovery.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration in hours**
1	**Introduction Database Concepts:** Introduction, characteristics of database, database system applications, file system v/s database system, View of data, data independence, data models, database languages, database design, DBMS system architecture, database users and DBA.	**03**
2	**Entity–Relationship Data Model:** Introduction, The Entity-Relationship (ER) Model: Entity types, Entity sets, types of attributes, keys, and relationships, Relationship constraints: cardinality and participation, Entity-Relationship (ER) diagram.	**05**
3	**Structured Query Language (SQL):** Introduction, SQL data definition, basic structure of SQL and basic operations, aggregate functions: group by having nested and complex queries, modification of the database, Views in SQL, Joins, Integrity constraints, Functions, Stored Procedures, Triggers, and Cursors.	**12**
4	**Relational Database Design:** Pitfalls in Relational-Database design, Concept of Normalization, Function Dependencies, First Normal Form, 2nd NF, 3rd NF, BCNF & 4th NF.	**05**
5	**Transaction Management and Concurrency:** Transaction concept, Transaction model, ACID properties, transaction atomicity and durability, concurrent executions.	**03**

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

List of Experiments: (However Instructor is free to design his/her own experiments)

1. To draw an ER diagram for a problem statement and design a relational schema for the same
2. To implement DDL SQL queries / commands
3. To implement DML SQL queries / commands
4. To implement aggregate functions
5. To implement Integrity Constraints
6. To implement Joins and Views
7. To implement nested queries and sub-queries
8. To implement triggers.
9. To implement procedures, functions and cursors.

Books Recommended:

Textbooks:

1. Korth, Slberchatz, Sudarshan, Database System Concepts, 6th edition, McGraw – Hill
2. Elmasri and Navathe, Fundamentals of Database Systems, Pearson education.
3. G. K. Gupta; Database Management Systems, 5th edition, McGraw – Hill.

Reference Books:

1. Peter Rob and Carlos Coronel, Database Systems Design, Implementation and Management, 5th edition, Thomson Learning.
2. P.S. Deshpande, SQL and PL/SQL for Oracle 10g, Black Book, 2009, Dreamtech Press.
3. Mark L. Gillenson, Paul raj Ponniah, Introduction to Database Management, Wiley
4. Oracle for Professional, Sharaman Shah, SPD.
5. Raghu Ramkrishnan and Johannes Gehrke, Database Management Systems, TMH.

Evaluation Scheme:

Semester End Examination (A):

Laboratory: A practical and oral examination will be conducted at the end of the semester based on entire syllabus.

Continuous Assessment (B):

Laboratory: (Term work): Term work shall consist of minimum 8 experiments and two assignments.

The distribution of marks for term work shall be as follows:

i. Laboratory work: 15 Marks
ii. Assignments: 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Third Year of B.Tech. Program in Mechanical Engineering:
Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="4">Semester: VI</td></tr>
<tr><td colspan="8">Course: Innovative Product Development IV</td><td colspan="4">Course Code: DJ19ILL2</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td rowspan="2">-</td><td rowspan="2">2</td><td rowspan="2">--</td><td rowspan="2">1</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>--</td><td>--</td><td>25</td><td>15</td><td>10</td><td>25</td></tr>
</table>

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value-added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product.

Outcome:

Learner will be able to:

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyse the impact of the proposed method of design and development of the product.
5. Develop interpersonal skills, while working as a member of the team or as the leader.
6. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
7. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

Guidelines for Assessment of the work:

1. The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
2. In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.

3. Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:
   A. Marks awarded by the supervisor based on log-book :20
   B. Marks awarded by review committee: 20
   C. Quality of the write-up: 10

Review/progress monitoring committee may consider the following points during the assessment.

In the semester V, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.

- First shall be for finalization of the product selected.
- Second shall be on finalization of the proposed design of the product.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

The semester V reviews may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:

- The write-up should be prepared as per the guidelines given by the department.
- The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester VI. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester VI.

Syllabus for Third Year Mechanical Engineering - Semester VI (Autonomous)
(Academic Year 2021-2022)

<table>
<tr><td colspan="8">Program: Third Year Mechanical Engineering</td><td colspan="3">Semester: VI</td></tr>
<tr><td colspan="8">Course: Environmental Studies</td><td colspan="3">Course Code: DJ19A5</td></tr>
<tr><td colspan="8"></td><td colspan="3"></td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
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<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>--</td><td>-</td><td>-</td></tr>
</table>

Pre-requisite: Interest in Environment and its impact on Human

Objectives:

1. Understand environmental issues such as depleting resources, pollution, ecological problems and the renewable energy scenario.
2. Familiarise environment related legislation
3. Understand and compare solar energy

Outcomes: Students should be able to

1. Understand how human activities affect environment
2. Understand the various technology options that can make a difference
3. Identify the advantages of solar energy over other forms of energy

Syllabus for Third Year Mechanical Engineering - Semester VI (Autonomous)
(Academic Year 2021-2022)

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Social issues and Environment** • Ecological footprint and Carrying Capacity • Depleting nature of Environmental resources such as soil, water minerals and forests • Carbon emissions and Global Warming.	4
2	**Technological growth for Sustainable Development** • Social, Economical and Environmental aspects of Sustainable Development • Renewable Energy Harvesting • Concept of Carbon credit, Green Building • Power and functions of Central Pollution Control Board and State Pollution Control Board	4
3	**Solar Energy** • Basic concept of Solar Radiation • Study of Solar panels • Comparative study of Solar energy with other energy sources	5

Books Recommended:

Text books:

1. Environmental Studies From Crisis to Cure, R. Rajagopalan, 2012
2. Textbook of Environmental Studies For Undergraduate Courses, Erach Bharucha
3. Solar Engineering, Sukhatme