Course Code	**PCC_DE101**				
Course Category	**Professional Core Course**				
Course Title	**Finite Element Methods**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 1 (one)**
	2	**1**	**2**	**4**	

Strong and weak forms of governing differential equations, and their equivalence, weighted residual and variational approaches, Ritz method, discretization of weak form and boundary conditions. convergence, bar and beam elements, truss and frame problems, isoparametric formulation, plane strain, plane stress and axi-symmetric problems, formulation of dynamics problems, laboratory work on solid mechanics problems, use of commercial code (student version) for specific problems on beams and trusses.

Text Books Recommended

1. J. N. Reddy, *An introduction to the finite element method*, vol. 1221. McGraw-Hill New York, 2010.

References

1. R. D. Cook and others, *Concepts and applications of finite element analysis*. John wiley \& sons, 2007.
2. L. J. Segerlind and H. Saunders, “Applied finite element analysis,” 1987.

Course Code	**PCC_DE102**				
Course Category	**Professional Core Course**				
Course Title	**Computational Fluid Dynamics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 1 (one)**
	2	**1**	**2**	**4**	

Introduction to *CFD*, computational approach to fluid dynamics and its comparison with experimental and analytical methods, basics of pde- elliptic, parabolic and hyperbolic equations, review of Navier-Stokes equation and simplified forms, solution methodology- *FDM* and *FVM* with special emphasis on *FVM*, stability, convergence and accuracy, finite volume method- domain discretization, types of mesh and quality of mesh, *SIMPLE*, pressure velocity coupling, checkerboard pressure field and staggered grid approach, practical aspects of computational modeling of flow domains, grid generation, types of mesh and selection criteria, mesh quality, key parameters and their importance, solution of *N-S* equations for incompressible flows.

Text Books Recommended

1. Patankar S.V. (1980) Numerical Heat Transfer and Fluid Flow, Hemisphere, Washington D.C., USA.
2. Ferziger J.H. & Peric M. (1999) Computational Methods for Fluid Dynamics, Springer, Berlin, Germany.

References

1. D. John and J. R. Anderson, “Computational fluid dynamics: the basics with applications,” *P. Perback, Int. ed., Publ.*, pp. 4–30, 1995.
2. H. K. Versteeg and W. Malalasekera, *An introduction to computational fluid dynamics: the finite volume method*. Pearson education, 2007.

Course Code	**HSM_DE103**				
Course Category	**Humanities and Social Sciences including Management**				
Course Title	**Design Thinking**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 1 (one)**
	2	**0**	**0**	**2**	

Definition, nature and scope of service science engineering management and design thinking, interdisciplinary and multidisciplinary characteristics of *SSMED*, T-shaped professional human resource development in Service Science, role of technology as operant resource, nature scope and significance of emerging, service ecosystems, service (Eco) systems perspective on value creation, nature, scope and characteristics of networks, Govinrajan's strategic concept of reverse engineering from emerging economies, Roger Martin conceptual framework of integrative Thinking.Design thinking evolution (Herbert Simon−Roger Martin), concepts, principles and practice, different schools of thought in design thinking, levels of design thinking, design thinking in management and its relevance to service and information economy. Strategic role of design thinking in strategy development and execution, applications in different organisational settings of the design thinking.
Note: Practical work, Case Studies & other assignments will be provided by the concerned faculty in the class.

Text Books Recommended

1. Brown, Tim. "Design thinking." *Harvard business review* 86.6 (2008): 84.

References

1. Spohrer, Jim, and Stephen K. Kwan. "Service science, management, engineering, and design (SSMED): An emerging discipline-outline & references." *International Journal of Information Systems in the Service Sector (IJISSS)* 1.3 (2009): 1-31.
2. Kupp, Martin, Jamie Anderson, and JörgReckhenrich. "Why design thinking in business needs a rethink." *MIT sloan management review* 59.1 (2017): 42
3. Martin, R. The Design of Business: Why Design Thinking is the Next Competitive Advantage. Harvard Business School Press, Boston, MA.
4. Martin, R., &Euchner, J. Design Thinking. Research Technology Management.
5. Riel, Jennifer, and Roger L. Martin. *Creating great choices: A leader's guide to integrative thinking*. Harvard Business Press, 2017.

Course Code	**PEC1A_DE104**				
Course Category	**Professional Elective-I Courses**				
Course Title	**Continuum Mechanics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 1 (one)**
	2	**1**	**0**	**3**	

Introduction to tensors, vectors and second order tensors, Tensor operation, properties of tensors, invariants, eigenvalues and eigenvectors of second order tensors, tensor fields, differentiation of tensors, divergence, Stokes and localization theorems, kinematics of deformation, Continuum hypothesis; Deformation mapping; Material (Lagrangian) and Spatial (Eulerian) field descriptions, length, area and volume elements in deformed configuration, material and spatial time derivatives, velocity and acceleration, linearized kinematics, balance laws, conservation of mass, balance of linear and angular momentum, cauchy stress tensor, state of stress, spatial and material forms of balance laws, concept of first and second Piola-Kirchoff stress tensors, conservation of energy, material frame-indifference, objective stress and stress-rates, material symmetry, constitutive relations for hyperelastic solids, generalized Hooke's law.

Text Books Recommended

1. D. S. Chandrasekharaiah and L. Debnath, *Continuum mechanics*. Elsevier, 2014.

References

1. L. E. Malvern, *Introduction to the Mechanics of a Continuous Medium*, no. Monograph. 1969.
2. C. S. Jog, *Continuum Mechanics: Volume 1: Foundations and Applications of Mechanics*. Cambridge University Press, 2015.

Course Code	**PEC2A_DE104**				
Course Category	**Professional Elective Courses**				
Course Title	**Tribology in Design**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 1 (one)**
	2	**1**	**2**	**4**	

Friction, theories of friction, friction control, surface texture and measurement, genesis of friction, instabilities and stick-slip motion, wear, types of wear, theories of wear, wear prevention, tribological properties of bearing materials and lubricants, lubrication, Reynolds's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), finite bearings, design of hydrodynamic journal bearings. hydrostatic, squeeze film circular and rectangular flat plates, variable and alternating loads, piston pin lubrication, application to journal bearings, elasto-hydrodynamic lubrication – pressure viscosity term in Reynolds's equation, Hertz' theory, Ertel-Grubin equation, lubrication of spheres, gear teeth and rolling element bearings, air lubricated bearings, tilting pad bearings, solution of lubrication models associated with vertical and horizontal hydrodynamic bearings and development of numerical codes using *FORTRAN* and *MATLAB* language.

Text Books Recommended

1. A. Cameron, "Basic Lubrication Theory.," *Ellis Horwood Ltd.,* p. 256, 1981.

References

1. S. Wen and P. Huang, *Principles of tribology*. John Wiley \& Sons, 2012.
2. D. D. Fuller, "Theory and practice of lubrication for engineers(Book)," *New York, Wiley-Interscience, 1984, 697 p*, 1984.
3. B. C. Majumdar, *Introduction to tribology of bearings*. AH Wheeler \& Company, 1986.
4. P. Huang, *Numerical calculation of elastohydrodynamic lubrication: methods and programs*. John Wiley \& Sons, 2015.
5. B. J. Hamrock, S. R. Schmid, and B. O. Jacobson, *Fundamentals of fluid film lubrication*. CRC press, 2004.

Course Code	**PEC3A_DE104**				
Course Category	**Professional Elective Course**				
Course Title	**Advanced Manufacturing Technology**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 1 (one)**
	2	**1**	**2**	**4**	

Micro-manufacturing and fabrication of microelectronic devices, introduction to *MEMS* and *NEMS*, clean rooms, semiconductors and silicon, crystal growth and wafer preparation, film deposition, oxidation, lithography, etching, diffusion and ion Implantation, metallization and testing, wire bonding and packaging, Micro-machining of MEMS devices, LIGA process, fabrication of microfluidic devices, additive manufacturing- basic principles of generative manufacturing, features and classification, stereolithography, selective laser sintering, selective powder binding, fused deposition modelling, laminated object manufacturing, solid ground curing, direct metal deposition, bio-printing, design and fabrication of scaffolds, atomic layer deposition, topology optimization, introduction to bio-materials and fabrication of medical devices, industry 4.0 and industrial internet of things- industry 4.0 basics, Industrial internet of things, contemporary sensing, and digital manufacturing, digital twins, industrial plant –the future architecture, machine learning and data sciences in industries, material characterization and design considerations, optical microscopy, micro hardness, *SEM* and *XRD* analysis of cast and welded structures.

Text Books Recommended

1. J. P. Davim, *Modern machining technology: A practical guide*. Elsevier, 2011.
2. C. K. Chua and K. F. Leong, *3D Printing and additive manufacturing: Principles and applications (with companion media pack)-of rapid prototyping*. World Scientific Publishing Company, 2014.

References

1. A. S. M. I. H. Committee, *ASM handbook*, vol. 7. ASM International, 1998
2. Gosh, A and Malik, A., Manufacturing Science, EWP
3. Gibsan, I., Rosen, D.W., and Stucker, B., Additive Manufacturing, Springer London, 2010
4. Kalpakjian, S and Schmid, S (2001), "Manufacturing Engineering and Technology", 4th edition, London: Pearson
5. Misra, S., Roy, C and Mukherjee A., Introduction to Industrial IOT and Industry 4.o, CRC Press Francis

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Course Code	**PEC1B_DE105**				
Course Category	**Professional Elective Course**				
Course Title	**Principles of Solar Thermal Engineering**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 1 (one)**
	2	**1**	**0**	**3**	

Introduction: Solar radiation and measurement, solar angles, day length, angle of incidence on tilted surface; sun-path diagrams; shadow determination, extra-terrestrial characteristic, measurement & estimation on horizontal and tilted surfaces, flat plate collectors: thermal analysis; heat capacity effect, testing methods; evacuated tubular collectors, air flat plate collectors, thermal analysis, thermal drying. selective surfaces: ideal coating characteristics; types and applications; anti-reflective coating, concentrating collector designs: classification, design and performance parameters, tracking systems, compound parabolic concentrators, parabolic trough concentrators, concentrators with point focus; heliostats; comparison of various designs: central receiver systems, parabolic trough systems, solar power plant, solar furnaces, solar Heating & cooling system, Liquid based solar heating system, natural, forced and gravity flow, mathematical modelling, Solar operated refrigeration systems, solar desiccant cooling; Performances of solar collectors, modelling of solar thermal system components.

and simulation; Design and sizing of solar heating systems: f–chart method and utilizability methods of solar thermal system evaluation.

Text Books Recommended

1. S. P. Sukhatme and J. K. Nayak, *Solar energy*. McGraw-Hill Education, 2017.

References

1. J. A. Duffie and W. A. Beckman, *Solar engineering of thermal processes*. Wiley New York, 1980.
2. D. Y. Goswami, F. Kreith, and J. F. Kreider, "Passive methods for heating, cooling, and daylighting," *Princ. Sol. Eng.*, pp. 297–336, 2000.

Course Code	**PEC2B-DE105**				
Category	**Professional Elective Courses**				
Course Title	**Cryogenics**				
Scheme and Credits	**L**	**T**	**P**	**Credits**	**Semester - 1 (one)**
	2	**1**	**0**	**3**	

Cryogenics and its applications, properties of cryogenic fluids, properties of materials at cryogenic temperature, gas-liquefaction and refrigeration systems, gas separation, cryocoolers, cryogenic Insulations, vacuum technology, instrumentation in cryogenics, liquid storage and transfer systems, cryostat design, dilution refrigerator and adiabatic demagnetization.

Text Books Recommended

1. K. D. Timmerhaus and T. M. Flynn, *Cryogenic process engineering*. Springer Science \& Business Media, 2013.

References

1. R. B. Scott, *Cryogenic engineering*. Books on Demand, 1959.
2. R. F. Barron and G. F. Nellis, *Cryogenic heat transfer*. CRC press, 2017.
3. R. W. Vance, "Cryogenic technology," *Am. J. Phys.*, vol. 32, no. 8, p. 651, 1964.