**Syllabi for Comprehensive Examination of Eligible Ph. D Scholars**

**Department:** Mechanical Engineering

**1) Research/Specialization Group: 1**

**(Name of the Group)**: **Thermal and Fluids Engineering**

**Syllabi for: P22ME016**

**Measurement Systems in Mechanical Engineering [50 Marks]**

**Analysis of Experimental Data**

Measurements error and uncertainty analysis, design of experiments, order of instruments and calibration, performance characteristics, frequency response.

**Sensors and Transducers**

Data sampling, signal conditioning and computer data acquisition. error response characteristic of sensors, measurement error.

**Measurement of Process Variables**

*Flow Measurement*: Positive displacement methods, flow obstruction methods, the sonic nozzle, hot wire and hot film anemometer, magnetic flow meter, flow visualization method, LDA.

*Temperature Measurement*: Temperature scales, the ideal gas thermometer, temperature measurement by mechanical effect, electrical effect, radiation, effect of heat transfer on radiation, transient response of thermal systems, thermocouples, temperature measurement in high-speed flow.

**Measurement of Properties of Moist Air**

Working substance in air conditioning, psychrometric properties, calculating the specific humidity (w), dew point temperature (DPT), degree of saturation, relative humidity (RH), enthalpy of moist air, humid specific heat, measurement of wet bulb temperature (WBT), thermodynamic wbt or temperature of adiabatic saturation, psychrometric chart, application of first law to a psychrometric process.

**References**

1. J. P. Holman, “Experimental methods for Engineers”, McGraw-Hill.
2. R. S. Sirohi and H. C. Radha Krishna, “Mechanical Measurements”, Wiley.
3. C.P. Arora, “Refrigeration and Air Conditioning”, McGraw Hill.

**Conduction and Radiation [50 Marks]**

**Governing Equations**

Basic modes of heat transfer, heat transfer mechanisms, governing laws, Reynolds transport theorem (RTT), derivation of energy equation, Fourier’s Law

**Conductive Heat Transfer systems**

Heat conduction equations in isotropic and anisotropic materials, Initial and boundary conditions, 1-D conduction problems without and with heat generation, plane wall, hollow cylinder, composite tube, hollow sphere, steady 2-D heat conduction problem, problems in cylindrical and spherical coordinate system, bounded 1-D domain, slab with heat generation, principle of superposition, thermal resistance, transient response, semi-infinite solid, polar co-ordinate (2-D), time dependent BCs

**Radiative Heat Transfer**

Mechanism of energy transport in thermal radiation divergence of radiative heat flux, laws of radiation, view factor and solid angle, radiation in presence of participating medium, radiation transport equations (RTE), radiative equilibrium

**References**:

1. F. P. Incropera & D.P. Dewitt, “Fundamentals of Heat and Mass Transfer”, John Willey & Sons
2. A. Bejan,“Convective Heat Transfer”, John Wiley and Sons
3. K. Muralidhar and G. Biswas, “Advanced Engineering Fluid Mechanics”, Narosa

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**Syllabi for:** **P21ME002**

**Measurement Systems in Mechanical Engineering [50 Marks]**

**Analysis of Experimental Data**

Measurements error and uncertainty analysis, design of experiments, order of instruments and calibration, performance characteristics, frequency response.

**Sensors and Transducers**

Data sampling, signal conditioning and computer data acquisition. error response characteristic of sensors, measurement error.

**Measurement of Process Variables**

*Pressure Measurement*: Dynamic response, dead weight pressure tester, Bourdon gauge; low pressure measurement techniques-the McLeod gauge, Pirani thermal conductivity gauge, Knudsen gauge.

*Flow Measurement*: Positive displacement methods, flow obstruction methods, the sonic nozzle, hot wire and hot film anemometer, magnetic flow meter, flow visualization method, LDA.

*Temperature Measurement*: Temperature scales, the ideal gas thermometer, temperature measurement by mechanical effect, electrical effect, radiation, effect of heat transfer on radiation, transient response of thermal systems, thermocouples, temperature measurement in high-speed flow.

**Measurement of Force, Torque and Power**

*Force Measurement*: Platform balance, Force to displacement conversion, conversion of force to hydraulic pressure, piezoelectric force transducer.

*Measurement of torque and power*: Torque Measurement: Electric generator as a dynamometer, Measurement of rotational speed,

**References**

1. J. P. Holman, “Experimental methods for Engineers”, McGraw-Hill.
2. R. S. Sirohi and H. C. Radha Krishna, “Mechanical Measurements”, Wiley.

**Combustion and Emission in Diesel Engines [50 Marks]**

**Operating Parameters**

Bore-stroke, dead centres, clearance and swept volumes,capacity, compression ratio, torque, power, mean effective pressure, specific fuel consumption, specific energy consumption, *problems*.

**Fuels**

CI engine fuels & their rating, alternating fuels to be used in CI and types, *problems*.

**Fuel Injection and Mixing**

Injection pumps, types of nozzles, injection timing, mechanical and pneumatic governors, spray characteristics, swirl, squish and tumble, electronic injection systems, *problems*.

**Combustion in C.I. Engines**

Stages, injection delay, factors influencing the delay, knocking, effect of variables on knocking, *problems*.

**Emissions and Control**

Primary and secondary air pollutants, other emissions, EGR, catalytic converter, DPF, emission norms.

**Measurement and Testing**

Frictional power, indicated power, brake power, fuel consumption, air consumption, efficiencies, pressure smoothing technique, measurement and calculation of pressure rise rate and net heat release rate, heat balance, performance maps, variables affecting performance, *problems*.

**References**:

1. V. Ganesan, “Internal Combustion Engines”, TMH

2. R. Stone, “Internal Combustion Engines”, The Macmillan Press Limited

3. C.R. Fergusan and A.T. Kirkpatrick, “Internal Combustion Engines”, John Wiley & Sons.

4. J.B. Heywood, “Internal Combustion Engine Fundamentals”, McGraw Hill.

 5. U.K. Saha, “IC Engines”, Course Material under QIP CD Cell Project, IIT Guwahati.

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**Signatures and Names of DRC Members:**

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Signature of DRC Chairman

Date