CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MET301	MECHANICS OF MACHINERY	PCC	3	1	0	4

Preamble:

This course aims to introduce the students to the fundamentals of the kinematics of various mechanisms and also its analysis for its displacement, velocity, and acceleration. The course will also cover the design of cams, theory and analysis of gears, gear trains and synthesis of mechanisms. The static force analysis of planar mechanisms and concept of gyroscopic couple along with its effect has also been included. This course also aids students in estimating unbalance in rotating and reciprocating masses and suggesting methods to overcome it.

Prerequisite: Engineering Mechanics (EST 100)

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the fundamentals of kinematics, various planar mechanisms and interpret the basic principles of mechanisms and machines
CO 2	Perform analysis and synthesis of mechanisms
CO 3	Solve the problem on cams and gear drives, including selection depending on requirement.
CO 4	Calculate the gyroscopic effect in various situations
CO 5	Analyse rotating and reciprocating masses for its unbalance

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 12
CO 1	2										
CO 2	3	3	3	2	2						
CO 3	3	3	2	2	2						
CO 4	3	2	1	1	1						
CO 5	3	2	2	1	2						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Explain the fundamentals of kinematics, various planar mechanisms and their components

1. Define the terms Link, Kinematic chain, Mechanism & Machine.

2. Explain Grashof's law.

3 Apply Kutzbach criterion to find the mobility of mechanisms.

4.Sketch and explain the various inversions of slider crank chain/fourbar chain

Course Outcome 2 (CO2) : Perform analysis and synthesis of mechanisms

1. Find out the velocity and acceleration of links of various planar mechanisms

2. State and prove the Arnold Kennedy's three centre theorem

2. Derive an expression for the magnitude and direction of Coriolis component of acceleration

3. Design a four bar mechanism to generate a given function accurate upto 3 positions

4. Do the static force analysis of four bar/slider crank mechanisms with different loading conditions

Course Outcome 3 (CO3): Solve the problem on cams and gear drives, including selection depending on requirement

1. Why is a roller follower preferred over knife edge follower

2. Design a cam profile to suit the situations for the follower such as SHM, dwell, constant velocity, uniform acceleration cycloidal motion etc

3. What do you understand by the term "interference" as applied to gears

4. Find out the gear train values of simple ,compound and epicyclic gear trains

Course Outcome 4 (CO4): Calculate the gyroscopic effect in various situations

1. What do you understand by Gyroscopic couple? Derive its formula for its magnitude.

2. Explain the effect of the gyroscopic couple on the reaction of the four wheels of a vehicle negotiating a curve.

3. Describe the working of a gyroscope.

4. How does gyroscopes help in guidance?

Course Outcome 5 (CO5): Analyse rotating and reciprocating masses for its unbalance

1. Distinguish between static balancing and dynamic balancing

2. Find out the magnitude and position of balancing masses required to balance unbalanced masses rotating in different planes.

3. What do you mean by primary and secondary unbalanced forces?

4. Find out the value of unbalanced primary force, primary couple, secondary force and secondary couple.

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B. TECH DEGREE EXAMINATION

Course Code: MET301

Course Name: MECHANICS OF MACHINERY

Max. Marks: 100 **Duration: 3 Hours**

PART – A

(ANSWER ALL QUESTIONS, EACH QUESTION CARRIES 3 MARKS)

1. Find out the degree of freedom in the following cases.

a) A planar link b) Two planar links joined by a revolute joint c) Three Planar links joined by three revolute joints

2. Describe the motion of the following items as pure rotation, pure translation or complex planar motion.

a) The hand of a clock **b)** The pen in an XY plotter **c)** connecting rod of an IC engine

3. A rod of length 1m with its one end fixed at origin is oriented in the positive X direction. It rotates in the XY plane with an angular velocity of 10rad/s clockwise direction and angular acceleration of 10rad/s^2 in the counter clock wise direction at a particular instant. Find out the total acceleration experienced at the free end.

4. Obtain the expression for velocity when the cam follower motion is cycloidal in nature.

5. How do we bring interchangeability of gears?

6. What do you mean by type synthesis?

7. Define the term 'friction circle'

8. How does a gyroscope help in guidance of aircrafts?

9. Does a rotor which is statically balanced require dynamic balancing?

10. Why do we go for partial balancing in the case of balancing of reciprocating masses?

Part B

(ANSWER ONE FULL QUESTION FROM EACH MODULE)

MODULE – I

11. a) Draw the inversions of the mechanism shown in Figure 1 which leads to double crank, double rocker and crank rocker mechanisms. Describe the nature of motion of each link in each case also **(9 marks)**

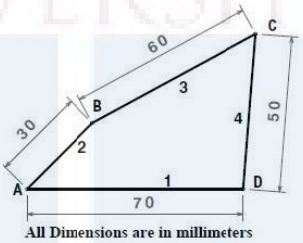


Figure-1

b) What are binary, ternary and quaternary links? **(5 marks)**

12. In the figure 2 given below the angular velocity of the crank OA is 600 r.p.m. Determine the linear velocity of the slider and angular velocity of all other links. The dimensions of various links are: OA=28 mm; AB = 44 mm; BC = 49 mm and BD = 46 mm. The centre distance between centres of rotation O and C is 65mm.The path of travel of slider is 11 mm below the fixed-point C **(14 marks)**

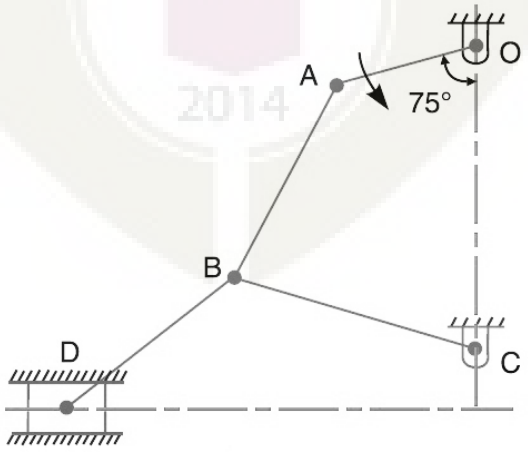


Figure-2

MODULE – II

13. a) What is meant by Coriolis component of acceleration. In which case does it occur? How is its direction determined? **(9 marks)**

b) A link OB rotating with a constant angular velocity of 2 rad/s in the counter clockwise direction and a block is sliding radially outwards on it with a uniform velocity of 0.75 m/s with respect to the rod as shown in the figure 3 below. Given OA =1 m and link OB is inclined to the positive X axis by 45°.Find out the absolute acceleration of block at A in magnitude and direction. **(5 marks)**

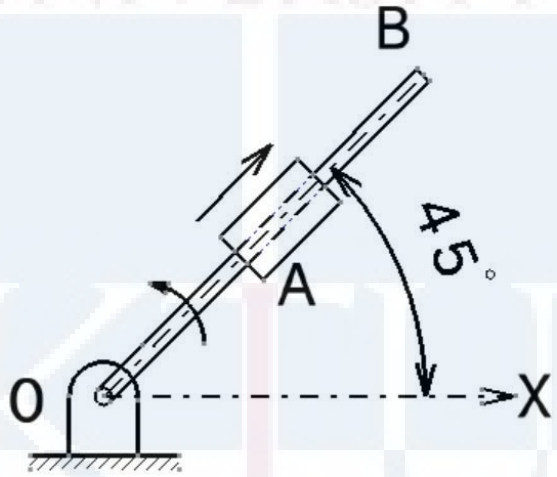


Figure-3

14. A cam rotating at 150 rpm operates a reciprocating follower of radius 2.5 cm. The follower axis is offset by 2.5 cm to the right. The least radius of the cam is 5 cm and the stroke of the follower is 5 cm. ascent and descent with take place by uniform acceleration and retardation. Ascent take place during 75° and descent during 90° of cam rotation. Dwell between ascent and descent is 60°. Draw the cam profile. Also sketch velocity and acceleration diagrams and mark salient values. **(14 marks)**

MODULE – III

15. In an epicyclic gear train as shown in Figure 4 the internal wheels A and B and the compound wheels C & D rotate independently about axis O. The wheels E and F rotate on pins fixed to the arm G.E gears with A and C and F gears with B and D. All wheels have the same module and the number of teeth are:

$Tc = 28$, $T_D = 26$, $T_E = T_F = 18$

i) Sketch the arrangement

ii) Find the number of teeth on A and B

iii) If the arm G makes 100 r.p.m clockwise and A is fixed, find the speed B

iv) If the arm G makes 100 r.p.m clockwise and wheel A makes 10 r.p.m counter clockwise, find the speed of wheel B **(14 marks)**

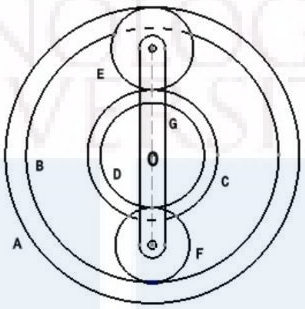


Figure-4

16. **a)** Design a four bar crank rocker to give 45° of rocker motion with a time ratio of 1:1.25 with 45° output rocker motion. **(9 marks)**

b) Design a slider crank mechanism to coordinate two positions of the input link and the slider for the following angular and linear displacement of the input link and slider respectively.

$\theta_{12} = 30°$ & $S_{12} = 100$ mm **(5 marks)**

MODULE – IV

17. The applied load on the piston of an offset slider-crank linkage shown in Fig. is 100 N, and the coefficient of friction between the slider and the guide is 0.27, using any method ,determine the magnitude and sense of torque T_2 applied on OA for the static equilibrium of the linkage. **(14 marks)**

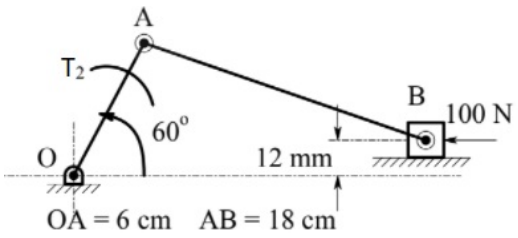


Figure-5

18 a) The wheels of a motor cycle have a moment of inertia of 5 kg m^2 and the engine parts, a moment of inertia of 0.35 kgm^2. The wheel axles and the crank shaft of the engine are all parallel to each other. If the ratio of reduction gears is 4:1, the wheel diameter is 700 mm, determine the magnitude and direction of the gyroscopic couple when the motor cycle negotiates a curve of 50 m radius at a speed of 50 km/hr. If the mass of the motor cycle with rider is 250 kg with centre of gravity at 65 cm above the ground in vertical position, determine the speed of the motor cycle rounding a curve of 60 m if the road condition permits an angle of heel of 45°. **(10 marks)**

b) Explain spin vector, precession vector, gyroscopic applied torque vector and gyroscopic reactive torque vector. **(4 marks)**

MODULE – V

19. A shaft carries four masses A, B, C and D which are placed in parallel planes perpendicular to the longitudinal axis. Th unbalanced masses at planes B and C are 3.6 kg and 2.6kg respectively and both are assumed to be concentrated at a radius of 25mm while the masses in planed A and D are both at a radius of 40mm.The angle between the planes B and C is 100° and that between B and A is 190°, both angles being measured in counter clock wise direction from the plane B .The planes containing A and B are 250mm apart and those containing B and C are 500mm.If the shaft is to be completely balanced ,determine

i) Masses at the planes A and D

ii) the distance between the planes C and D

iii) the angular position of the mass D **(14 marks)**

20. A five cylinder in-line engine running at 750 r.p.m. has successive cranks 144° apart, the distance between the cylinder centre lines being 375 mm. The piston stroke is 225mm and the ratio of the connecting rod to the crank is 4. Examine the engine for balance of primary and secondary forces and couples. Find the maximum values of these and the position of the

central crank at which these maximum values occur. The reciprocating mass for each cylinder is 15 kg. **(14 marks)**

Syllabus

Module 1

Introduction to kinematics and mechanisms - various mechanisms, kinematic diagrams, degree of freedom- Grashof's criterion, inversions, coupler curves mechanical advantage, transmission angle. straight line mechanisms exact, approximate. Displacement, velocity analysis– relative motion - relative velocity. Instantaneous centre -Kennedy's theorem.

Module 2

Acceleration analysis- Relative acceleration - Coriolis acceleration - graphical and analytical methods.
Cams - classification of cam and followers - displacement diagrams, velocity and acceleration analysis of SHM, uniform velocity, uniform acceleration, cycloidal motion
Graphical cam profile synthesis, pressure angle.

Module 3

Gears – Classification- terminology of spur gears – law of gearing -tooth profiles- involute spur gears- contact ratio - interference - backlash - gear standardization – interchangeability. Gear trains - simple and compound gear trains - planetary gear trains.

Kinematic synthesis (planar mechanisms) - type, number and dimensional synthesis – precision points. Graphical synthesis for motion - path and prescribed timing - function generator. 2 position and 3 position synthesis – overlay Method. Freudenstein's equation.

Module 4

Static force analysis- Analysis of four bar linkages and slider crank mechanism, graphical method, Matrix method, principle of virtual work. Analysis of four bar and slider crank mechanisms with sliding and pin friction.

Gyroscopic couples-spin, precession and applied gyroscopic couple vectors-effects on the stability of two wheelers, four wheelers, sea vessels and air crafts, application of gyroscopes

Module 5

Static balancing-dynamic balancing-balancing of several masses in the same plane-several masses in different planes-graphical and analytical method-force and couple polygons.

Balancing of reciprocating masses -Single cylinder engine-multi cylinder engine -V-engine

Text Books

1. Ballaney P. L., Theory of Machines and Mechanisms, Khanna Publishers,2005
2 . S. S. Rattan, Theory of Machines, Tata Mc Graw Hill,2009

Reference Books

1. C. E. Wilson, P. Sadler, Kinematics and Dynamics of Machinery, Pearson Education,2005.
2. D.H. Myskza, Machines and Mechanisms Applied Kinematic Analysis, Pearson Education,2013
3. G. Erdman, G. N. Sandor, Mechanism Design: Analysis and synthesis Vol I & II, Prentice Hall of India,1984.
4. Ghosh, A. K. Malik, Theory of Mechanisms and Machines, Affiliated East West Press,1988
5. J. E. Shigley, J. J. Uicker, Theory of Machines and Mechanisms, McGraw Hill,2010
6. Norton, Kinematics and Dynamics of Machinery, Tata McGraw Hill,2009

Course Contents and Lecture Schedule

No 1	Topic **Module-1-**	No. of lectures **10 Hours**
1.1	Introduction to kinematics and mechanisms	1 Hr
1.2	Various mechanisms	2 Hr
1.3	Kinematic diagrams, degree of freedom, Grashof's criterion	2 Hr
1.4	Inversions	1 Hr
1.5	Coupler curves mechanical advantage, transmission angle.	1 Hr
1.6	Straight line mechanisms exact, approximate	1 Hr
1.7	Displacement, velocity analysis, Kennedy's theorem.	2 Hr
2	**Module 2-**	**10 Hours**

2.1	Acceleration analysis- Relative acceleration - Coriolis acceleration -	1 Hr
2.2	Graphical and analytical methods. .	2Hr
2.3	Cams - classification of cam and followers	1 Hr
2.4	Displacement diagrams, velocity and acceleration analysis of SHM,	2 Hr
2.5	Uniform velocity,uniform acceleration and cycloidal motion	1 Hr
2.5	Graphical cam profile synthesis, pressure angle.	2 Hr
2.6	Analysis of tangent cam with roller follower and circular cam with flat follower	1 Hr
3	**Module-3**	**9 Hours**
3.1	Gears – terminology of spur gears – law of Gearing	1 Hr
3.2	involute spur gears - contact ratio- interference - backlash - gear standardization-interchangeability	1 Hr
3.3	Gear trains - simple and compound gear trains - planetary gear trains	2 Hr
3.4	Kinematic synthesis (planar mechanisms) - type, number and dimensional synthesis – precision points.	2 Hr
3.5	Graphical synthesis for motion - path and prescribed timing - function generator. 2 position and 3 position synthesis	2 Hr
3.6	Overlay Method. Freudenstein's equation	1 Hr
4	**Module-4-**	**8 Hours**
4.1	Static force analysis- Analysis of four bar linkages and slider crank mechanism	2 Hr
4.2	Graphical method, Matrix method	1 Hr
4.3	principle of virtual work	1 Hr
4.4	Analysis of four bar and slider crank mechanisms with sliding and pin friction.	1 Hr

4.4	Gyroscopic couples-spin, precession and applied gyroscopic couple vectors	2 Hr
4.5	Effects on the stability of two wheelers **,** Four wheelers, sea vessals and air crafts	1 Hr
5	**Module-5- Kinematics-synthesis**	**8 Hours**
5.1	Static balancing-dynamic balancing-	2 Hr
5.2	balancing of several masses in the same plane	1 Hr
5.3	several masses in different planes-graphical and analytical method	1 Hr
5.4	force and couple polygons	1 Hr
5.5	Balancing of reciprocating masses -Single cylinder engine	1 Hr
5.6	multi cylinder engine-v engine-inline engine	2 Hr

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
MET303	THERMAL ENGINEERING	PCC	3	1	0	4

Preamble: This course involve the application of principles studied in thermodynamics to different energy conversion systems like steam turbine, steam nozzle, steam powerplant, IC engines and refrigeration systems. This course also covers the methods for improving and evaluating the performance of different energy conversion systems. This course also helps to understand the combustion phenomenon in IC engines.

Prerequisite: MET202 Engineering Thermodynamics

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the working of steam power cycle and related components
CO 2	Discuss the working of steam turbines and methods for evaluating the performance
CO 3	Illustrate the performance testing and evaluation of IC engines
CO 4	Explain the combustion phenomenon and pollution in IC engines
CO 5	Discuss the principles of refrigeration and air-conditioning and basic design considerations

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	**3**	3	2									
CO 2	**3**	3	2									
CO 3	**3**	3	2									
CO 4	**3**	3	2									
CO 5	**3**	3	2									

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	10
Understand	20	20	20
Apply	20	20	70
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. In a reheat Rankine cycle, steam at a pressure of 40 bar and 300°C is expanded through a turbine to a pressure of 4 bar. It is then heated at a constant pressure to 300ºC and then expanded to 0.1 bar. Estimate the work done per kg of steam flowing through the turbine, the amount of heat supplied during the reheat process and the cycle efficiency. Neglect pump work.

2. Dry saturated steam enters a frictionless adiabatic nozzle with negligible velocity at a temperature of 300 °C. It is then expanded to a pressure of 40 bar. For a mass flow rate of 2 kg/s, calculate the exit velocity of the steam.

3. With the help of a figure explain the working of Babcock and Wilcox boiler.

Course Outcome 2 (CO2):

1. In an impulse steam turbine, steam issues from the nozzle with a velocity of 1200 m/s. The nozzle angle is 20^o and the mean blade velocity is 400 m/s. The inlet and outlet blade angles are equal. The blade velocity coefficient is 0.8. The mass of steam flowing through the turbine per hour is 950 kg. Calculate: (i) Blade angles. (ii) Relative velocity of steam entering the blades (iii) Tangential force on the blades. (iv) Power developed. (v) Blade efficiency.

2. In a reaction turbine, the mean blade speed is 150 m/s and the ratio of blade speed to steam speed is 0.625. The outlet angles of fixed and moving blades are 20^o and 30^o respectively. Calculate (i) the degree of reaction (ii) the adiabatic enthalpy drop in a pair of blade rings and (iii) the gross stage efficiency. The specific volume of steam at fixed blade outlet is 0.567 m^3 and at moving blade outlet 0.6 m^3. Assume the efficiency of blades when considered as nozzles 0.90 and $k^2 = 0.86$, where k is the blade velocity coefficient.

3. Derive the conditions for maximum efficiency of a Parsons reaction turbine.

4. Discuss the means of improving the performance of a steam turbine.

Course Outcome 3(CO3):

1. A 4-cylinder four stroke petrol engine is working based on the following data: Air-fuel ratio by weight = 15:1, calorific value of the fuel = 45000 kJ/kg, mechanical efficiency = 80 %, air- standard efficiency = 54 %, relative efficiency = 70 %, volumetric efficiency = 75 %, stroke/bore ratio = 1.25, suction conditions = 1 bar and 30 ^{o}C, r.p.m. = 2500, brake power = 70 kW. Calculate: (i) Compression ratio. (ii) Indicated thermal efficiency. (iii) Brake specific fuel consumption. (iv) Bore and stroke.
2. Discuss the working of a rotary engine and its merits and demerits over conventional IC engines.
3. How Morse test and retardation test helps to find the friction power of an engine?
4. Explain the procedure for heat balance test and its significance.

Course Outcome 4 (CO4):

1. Explain equivalence ratio and its significance in IC engine combustion.
2. Explain different stages of SI engine combustion with the help of pressure-crank angle diagram.
3. Discuss detonation in SI engine, cause and effects and the engine variable influencing the same.
4. Explain different pollution control methods employed for reducing the emissions in IC engines.

Course Outcome 5 (CO5):

1. Derive the expression for COP of an ideal air refrigeration cycle.
2. A food storage locker with R12 refrigerant requires a refrigeration of 2400 kJ/min. capacity has an evaporator temperature of 263 K and a condenser temperature of 303 K.The refrigerant is sub cooled by 6 ^{o}C before entering the expansion valve and vapour is superheated by 7 ^{o}C before leaving the evaporator coil. The refrigeration compressor is a two cylinder single acting with stroke equal to 1.25 times the bore and operates at 1000 rpm. Calculate i) Mass of refrigerant circulated/min. ii) Heat removed by condenser/min iii) Theoretical bore and stroke.
3. Sensible and latent loads on a space are 50 kW and 10 kW respectively. Cold and dehumidified air at 10 ^{o}C DBT and 90 % RH is used to maintain the space condition at 24 ^{o}C DBT. Find i) RSHF ii) space relative humidity and iii) mass flow rate of supply air?

MODEL QUESTION PAPER

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

V SEMESTER BTECH DEGREE EXAMINATION

MET303: THERMAL ENGINEERING

Maximum: 100 Marks Duration:3 hours

Use of Steam tables, Refrigeration tables, Charts and Psychrometric chart is permitted.

PART A

Answer all questions, each question carries 3 marks

1. Explain Rankine cycle with help of a T-S diagram.
2. Differentiate between fire tube boiler and water tube boiler.
3. List the difference between throttle governing and nozzle governing.
4. Explain degree of reaction of a steam turbine.
5. With the help of a diagram explain turbocharging.
6. Explain the procedure of Morse test.
7. Discuss about pollutants coming from a CI engine.
8. What do you meant by Octane number?
9. Why reversed Carnot cycle is practically impossible to execute?
10. Define bypass factor and mention its significance. (10×3=30 Marks)

PART B

Answer one full question from each module

MODULE 1

11. a) Steam at a pressure of 15 bar and 250 ^{o}C is expanded through a turbine to a pressure of 4 bar. It is then reheated at constant pressure to initial temperature of 250 ^{o}C and finally expanded to condenser pressure of 0.1 bar. Calculate efficiency of the cycle. What will be the efficiency if reheating is not employed? Pump work can be neglected. (8 marks)

    b) Derive the expression for mass flow rate of steam through a nozzle and obtain the critical pressure ratio. (6 marks)

12. a) With the help of a neat figure explain the working of a Benson boiler. What are its merits over other boilers? (8 marks)

b) With the help of T-s and p-h diagram explain the significance of binary vapour cycle. (6 marks)

MODULE 2

13. a) Derive the condition for maximum efficiency of a reaction turbine. (6 marks)

b) With the help of figures enumerate the difference between pressure compounding and velocity compounding of steam turbines. (8 marks)

14. a) What do you meant by reheat factor? List the parameters influencing the value of reheat factor. (4 marks)

b) In an impulse steam turbine, steam issues from the nozzle with a velocity of 1200 m/s. The nozzle angle is 20^o and the mean blade velocity is 400 m/s. The inlet and outlet blade angles are equal. The blade velocity coefficient is 0.8. The mass of steam flowing through the turbine per hour is 950 kg. Calculate: (i) Blade angles. (ii) Relative velocity of steam entering the blades. (iii) Tangential force on the blades. (iv) Power developed. (v) Blade efficiency. (10 marks)

MODULE 3

15. a) With the help of a neat figure explain the working of Wankel engine. Mention its merits and demerits over conventional IC engines. (9 marks)

b) Discuss the effect of variable specific heat in actual cycle of IC engines. (5 marks)

16. a) The following observations were recorded during a trial of a four stroke single cylinder diesel engine for a trial duration of 30 min. Fuel consumption is 4 liters, Calorific value of fuel 43 MJ/kg, specific gravity of the fuel = 0.8, average area of indicator diagram = 8.5 cm^2, length of indicator diagram = 8.5 cm, spring constant= 5.5 bar/cm, brake load = 150 kg, spring balance reading = 20 kg, effective brake wheel diameter = 1.5 m, speed = 200 rpm, cylinder diameter = 30 cm, stroke = 45 cm. Calculate i) indicate power ii) brake power iii) mechanical efficiency iv) specific fuel consumption in kg/kWh and v) indicated thermal efficiency. (10 marks)

b) Explain the concept of charge stratification in IC engines. (4 marks)

MODULE 4

17. a) With the help of pressure-crank angle diagram explain different stages of CI engine combustion. (8 marks)

    b) Explain the phenomenon of detonation in SI engine based on autoignition theory. (6 marks)

18. a) With the help of figures compare different types of SI engine combustion chambers. (8 marks)

    b) Discuss any two emission control methods employed in reducing the emission of CI engine. (6 marks)

MODULE 5

19. a) A freezer of 20 TR capacity has evaporator and condenser temperature of -30 ^{o}C and 25 ^{o}C respectively. The refrigerant R-12 is sub-cooled by 4 ^{o}C before entering the expansion valve and is superheated by 5 ^{o}C before entering the evaporator. If a six cylinder single acting compressor with stroke equal to bore running at 1000 rpm. is used. Determine i) COP ii) Theoretical piston displacement per minute iii) Theoretical bore and stroke. (9 marks)

    b) Derive an expression for COP of a Reversed Brayton cycle for air refrigeration system. (5 marks)

20. a) 2.5 kg of air is cooled and dehumidified from 30 ^{o}C DBT, 40% RH to 15 ^{o}C DBT & 80% RH in a cooling and dehumidifying coil. Find (i) ADP, (ii) Bypass Factor and (iii) Heat Transfer. If bypass factor is halved keeping the ADP same find (iv) exit air condition and (v) Heat Transfer. (10 marks)

    b) Define i) DPT ii) RH ii) SHF and iv) ADP. (4 marks)

Module 1

Steam engineering- Rankine cycle, Modified Rankine cycle, Relative efficiency, Improvement in steam cycles-Reheat, Regenerative and Binary vapour cycle. Steam Boilers: Types of boilers, Cochran boiler, Babcock and Wilcox boiler, Benson boiler, La Mont boiler, Loeffler boiler, Velox boiler, Boiler Mountings and Accessories. Steam nozzles: -Types of nozzle,Velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, super saturated flow.

Module 2

Steam turbines: classification, compounding of turbines-pressure velocity variation, velocity diagrams, work done, efficiency, condition for maximum efficiency, multistage turbines-condition line, stage efficiency. Steam turbine performance-reheat factor, degree of reaction, cycles with reheating and regenerative heating, governing of turbines.

Module 3

Actual cycle analysis of IC engines- Deviation of actual engine cycle from ideal cycle, variable specific heats. Rotary engines, Stratified charge engine, Super charging and turbo charging. Performance Testing of I C Engines- Indicator diagram, mean effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency, mechanical efficiency, volumetric efficiency, thermal efficiency, relative efficiency and Specific fuel consumption. Morse test, Heat balance test and Retardation test.

Module 4

Combustion in I.C. Engines- Analysis of fuel combustion-A/F ratio, equivalence ratio, excess air. Combustion phenomena in S.I. engines; Ignition limits, stages of combustion in S.I. Engines, Ignition lag, velocity of flame propagation, auto ignition, detonation; effects of engine variables on detonation; theories of detonation, octane rating of fuels; pre-ignition; S.I. engine combustion chambers. Combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers. Air pollution from I.C. Engine and its control: Pollutants from S.I. and C.I. Engines, Methods of emission control.

Module 5

Refrigeration– Reversed Carnot cycle, Air refrigeration system- Reversed Joule cycle. Vapour compression systems-simple cycle - representation on T- s and P- h Diagrams. Effect of operating parameters on COP, Methods of improving COP of simple cycle, Super heating and under cooling. Psychometric properties – specific humidity, relative humidity and degree of saturation, thermodynamic equations, enthalpy of moisture, DBT, WBT and DPT, psychrometers, psychometric chart. Psychometric processes- adiabatic mixing, sensible heating and cooling, humidifying and dehumidifying, air washer, bypass factor, sensible heat factor, Comfort and industrial air conditioning, Comfort air conditioning- factors affecting

human comfort, Effective temperature, comfort chart, Summer air conditioning, factors affecting, cooling load estimation.

Text Books

1. Rudramoorthy , Thermal Engineering, McGraw Hill Education India, 2003.

2. R.K Rajput, Thermal Engineering, Laxmi publications, 2010.

3. Arora C. P, Refrigeration and Air-Conditioning, McGraw-Hill, 2008.

4. Arora S. C. and Domkundwar, Refrigeration and Air-Conditioning, Dhanpat Rai, 2010.

Reference Books

1. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill, 2002.

2. J.B.Heywood, I.C engine fundamentals. McGraw-Hill, 2011.

3. Rathore, Thermal Engineering, McGraw Hill Education India, 2010.

4. Dossat. R. J, Principles of Refrigeration, Pearson Education India, 2002.

5. Stoecker W.F, Refrigeration and Air-Conditioning, McGraw-Hill Publishing Company, 2009.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1		
1.1	Steam engineering- Rankine cycle, Modified Rankine cycle, Relative efficiency, Improvement in steam cycles-Reheat, Regenerative and Binary vapor cycle.	4
1.2	Steam Boilers: Types of boilers, Cochran boiler, Babcock and Wilcox boiler, Benson boiler, , La Mont boiler, Loeffler boiler, Velox boiler, Boiler Mountings and Accessories.	3
1.3	Steam nozzles:-Types of nozzle- Velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, super saturated flow.	2
2		
2.1	Steam turbines: classification, compounding of turbines-pressure velocity variation, velocity diagrams.	3
2.2	Work done, efficiency, condition for maximum efficiency, multistage turbines-condition line, stage efficiency.	3
2.3	Steam turbine performance-reheat factor, degree of reaction, cycles with reheating and regenerative heating, governing of turbines.	3
3		

3.1	Actual cycle analysis of IC engines- Deviation of actual engine cycle from ideal cycle, variable specific heats.	2
3.2	Rotary engines, Stratified charge engine, Super charging and turbo charging.	2
3.3	Performance Testing of I C Engines- Indicator diagram, mean effective pressure. Torque, Engine power- BHP, IHP. Engine efficiency, mechanical efficiency, volumetric efficiency, thermal efficiency and relative efficiency, Specific fuel consumption.	3
3.4	Morse test, Heat balance test and Retardation test.	2
4		
4.1	Combustion in I.C. Engines- Analysis of fuel combustion-A/F ratio, equivalence ratio, excess air.	1
4.2	Combustion phenomena in S.I. engines; Ignition limits, stages of combustion in S.I. Engines, Ignition lag, velocity of flame propagation, auto ignition, detonation; effects of engine variables on detonation; theories of detonation, octane rating of fuels; pre-ignition; S.I. engine combustion chambers.	3
4.3	Combustion in C.I. Engines; delay period; variables affecting delay period; knock in C.I. engines, Cetane rating; C.I. engine combustion chambers.	3
4.4	Air pollution from I.C. Engine and its control: Pollutants from S.I. and C.I. Engines, Methods of emission control.	2
5		
5.1	Refrigeration– Reversed Carnot cycle, Air refrigeration system-Reversed Joule cycle.	2
5.2	Vapour compression systems-simple cycle - representation on T- s and P- h Diagrams. Effect of operating parameters on COP, Methods of improving COP of simple cycle, Super heating and under cooling.	2
5.3	Psychometric properties – specific humidity, relative humidity and degree of saturation- thermodynamic equations- enthalpy of moisture- DBT, WBT and DPT–psychrometers, psychometric chart.	1
5.4	Psychometric processes- adiabatic mixing, sensible heating and cooling, humidifying and dehumidifying, air washer, bypass factor, sensible heat factor.	2
5.5	Comfort and industrial air conditioning, Comfort air conditioning-factors affecting human comfort, Effective temperature, comfort chart, Summer air conditioning, factors affecting, cooling load estimation.	2

MET305	INDUSTRIAL & SYSTEMS ENGINEERING	CATEGORY	L	T	P	CREDIT
		PCC	3	1	0	4

Preamble:

This course is designed to facilitate the students to acquire knowledge about management principles and practices of an industry. It empowers the students to amalgamate their knowledge of materials management, inventory management, lean manufacturing, agile manufacturing, industrial relations and enterprise resource planning and thus inculcate the skills needed to apply these principles in an industry.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	**Implement various tools and techniques in industrial engineering**
CO 2	**Calculate the inventory system for a given requirement**
CO 3	**Explain the importance of industrial relations**
CO 4	**Select the lean manufacturing tools to find and eliminate wastes**
CO 5	**Identify the framework of agile manufacturing**
CO 6	**Identify core and extended modules of enterprise resource planning**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	**2**				2				2		2	2
CO 2	**3**			2						2	2	2
CO 3						1			2	2	1	2
CO 4	**2**	1		2	1						2	2
CO 5				2	1				2		2	2
CO 6	**2**				3						2	2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	40	60
Apply	20		20
Analyse			
Evaluate			
Create			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment Test (2 numbers)	: 25 marks
Assignment/Quiz/Course project	: 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Calculate the breakeven point for the product.

2. What are the functions of Industrial Engineering?

3. What are the human factors to be considered while designing a new product?

Course Outcome 2 (CO2)

1. List various types of material handling equipments

2. Determine the optimum quantity to be ordered

3. Describe the role played by the materials management function in enabling an organisation to achieve profitability.

Course Outcome 3(CO3):

1. Define 'Job Satisfaction'.

2. Describe the causes of poor industrial relations.

3. What is meant by 'collective bargaining'?

Course Outcome 4 (CO4):

1.Compare the inventory levels in conventional and lean manufacturing systems.

2.Expand the Japanese terms of 5S

3.Describe the basic elements of lean manufacturing

Course Outcome 5 (CO5):

1. Describe the components of agile manufacturing system

2. List the measures that are used to measure innovation in agile production system.

3. How do strategic linkages aid the organisation to acquire agility?

Course Outcome 6 (CO6):

1. Enumerate ERP implementation stages.

2. With the aid of a block diagram, explain the construction and working of ERP framework.

3. Describe ERP related technology

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION

MET305 INDUSTRIAL & SYSTEMS ENGINEERING

Max. Marks: 100 Duration: 3 Hours

PART A

Answer ALL questions, each carries 3 marks.

1. What are the human factors to be considered while designing a new product?
2. Describe the procedure followed while designing a product.
3. List various types of material handling equipments
4. Describe the concept of JIT manufacturing system
5. Describe the causes and effects of industrial disputes and how it can be eliminated
6. What are the methods of elimination of fatigue?
7. Expand the Japanese terms of 5S.
8. Describe the characteristics of agile manufacturing.
9. State the evolution of ERP.
10. What is Online Analytical Processing?

PART B

Module 1

11. a) How inventories are classified and costs associated by inventories? (5)

b) A manufacturer has to supply 10,000 units of product annually. The unit cost is Rs. 2 and it costs Rs.36 to place an order. The inventory carrying cost is estimated at 9% of average inventory investment. Determine 1. EOQ 2.Optimum number of orders to be placed per annum. 3. Minimum total cost of inventory (9)

12 a) What are the principles of good product design (10)

b) The fixed cost of producing a product in a company is Rs. 8,00,000. Variable cost per unit of the product is Rs. 30. Each unit of the product is going to be sold at a price of Rs. 180. Determine the breakeven point of this product. (4)

Module 2

13. Describe the role played by the materials management function in enabling an organisation to achieve profitability. (14)

14. a) What is meant by quantity discount? (4)

b) A retailer procures batteries for quartz watches and sells them to watch repair shops. The price paid by the retailer varies on the basis of the quantities of batteries procured by him. The quantity and the price/unit pattern offered to him are given below:

Quantity (Q)	Price per one unit of battery
$0 \leq Q < 100$	Rs.20
$100 \leq Q < 200$	Rs.18
$200 \leq Q$	Rs.15

The monthly demand for the batteries is 600 units. The storage cost is 15% of unit cost of the battery and the cost of ordering is Rs.30 per order. Determine the optimum quantity to be ordered by the retailer so that the total cost of procurement is minimum. (10)

Module 3

15. (a) List any five objectives of Trade union. (5)

(b) Trace the history of Trade unionism. (9)

16 (a) Explain conditions to be met for maintaining good industrial relations. (7)

(b) Describe the causes of poor industrial relations. (7)

Module 4

17. (a) Enumerate the objectives and key principles of lean manufacturing paradigm. (7)

(b) Compare traditional and lean manufacturing paradigms. (7)

18. List and describe any ten components of agile manufacturing system. (14)

Module 5

19. Describe the key processes of "Customer Relationship Management". (14)

20 a) With the aid of a block diagram, explain the construction and working of ERP framework. (7)

(b) Explain the differences between 'Business Engineering' and 'Business Process Reengineering'. (7)

Syllabus

Module 1

Introduction to Industrial Engineering - Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering - Field of application of Industrial Engineering - Design function - Objectives of design- Development of designs- prototype, production and testing - Human factors in design - Principles of good product design- tolerance design- quality and cost considerations- product life cycle- standardization, simplification, diversification- concurrent engineering- comparison of production alternatives - Economic aspects- C-V-P analysis – simple problems.

Module 2

Introduction to materials management – objectives – Types of material handling equipments - principles of material handling –Material selection – value analysis – make or buy decisions- Purchasing and procedures. Basic inventory management - Inventory -Functions, Costs, Classifications - EOQ Models- Assumptions- Quantity discount model- Q system- P system- Reorder level - Simple problems- Concept of JIT manufacturing system.

Module 3

Industrial relations- Psychological attitudes to work and working conditions - fatigue- Methods of eliminating fatigue- Effect of Communication in Industry-Industrial safety-personal protective devices-, causes and effects of industrial disputes- Collective bargaining- Trade union - Workers participation in management.

Module 4

Principles of Lean Manufacturing(LM) – Basic elements of LM– Introduction to LM Tools- Concept of wastes in LM and their narration - stages of 5S and waste elimination - Conventional Manufacturing versus Lean Manufacturing - Need for LM. Agile manufacturing - Definition, business need, conceptual frame work, characteristics, and generic features - Approaches to enhance ability in manufacturing - Managing people in agile organization

Module 5

Introduction of enterprise resource planning (ERP)- Concept of Enterprise, ERP Overview - Integrated information system - Myths about ERP – Evolution of ERP- Benefits of ERP implementation - Success and failure factors of ERP implementation - Small, medium and large enterprise vendor solutions- ERP and related technology: Business intelligence (BI), E-Commerce and E-Business, Business Process Reengineering (BPR), Data warehousing, Data mining, Online Analytical Processing(OLAP), Product lifecycle management(PLC), Supply chain

management(SCM), Customer relationship management (CRM)- ERP implementation challenges - Emerging trends on ERP

Text Books

1. Martand T. Telsang, "Industrial Engineering & Production Management", S. Chand and Company Limited, 2018.

2. M. Mahajan, "Industrial Engineering & Production Management", Dhanpat Rai & Co. (P) Limited, 2015.

3. O. P. Khanna, "Industrial Engineering and Management", Dhanpat Rai Publications, 2018.

4. James P. Womack, Daniel T. Jones and Daniel Roos, "The Machine That Changed the World", Free Press, New York, 2007.

5. Alexis Leon, "ERP Demystified", Tata McGraw Hill Education Private Limited, New Delhi, 2008.

Reference Books

1. Kjell Zandin and Harold Maynard, "Maynard's Industrial Engineering Handbook", McGraw-Hill Education, 2001.

2. Philips E. Hicks, "Industrial Engineering and Management – A new perspective", McGraw Hill International Editions, New York, 1994.

3. B. Kumar "Industrial Engineering and Management ", Khanna Publishers,2013.

4. S.R. Devadasan, V. Mohan Sivakumar, R. Murugesh and PR Shalij, "Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities" PHI Learning private Limited, New Delhi, 2012.

5. Ravi Shankar, "Industrial Engineering and Management", Golgotia Publications Pvt Ltd, NewDelhi, 2009.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	Introduction to Industrial Engineering	
1.1	Evolution of modern Concepts in Industrial Engineering - Functions of Industrial Engineering - Field of application of Industrial Engineering	2
1.2	Design function - Objectives of design- Development of designs- prototype, production and testing - Human factors in design - Principles of good product design- tolerance design	2
1.3	Quality and cost considerations- product life cycle- standardization, simplification, diversification- concurrent engineering	2
1.4	Comparison of production alternatives - Economic aspects- C-V-P analysis – simple problems	2
2	Introduction to materials management	

2.1	Objectives – Types of material handling equipments	1
2.2	Principles of material handling –Material selection – value analysis	2
2.3	Make or buy decisions-Purchasing procedure	1
2.4	Inventory -Functions, Costs, Classifications	1
2.5	EOQ Models- Assumptions- Quantity discount model- Q system- P system- Reorder level - Simple problems, JIT	3
3	Industrial relations	
3.1	Psychological attitudes to work and working conditions	1
3.2	Fatigue- Methods of eliminating fatigue	1
3.3	Effect of Communication in Industry-Industrial safety-personal protective devices	2
3.3	Causes and effects of industrial disputes- Collective bargaining	2
3.4	Trade union - Workers participation in management	1
4	Lean Manufacturing and Agile manufacturing	
4.1	Principles of Lean Manufacturing(LM) – Basic elements of LM– Introduction to LM Tools	2
4.2	Concept of wastes in LM and their narration	1
4.3	Stages of 5S and waste elimination	2
4.4	Conventional Manufacturing versus Lean Manufacturing - Need for LM.	1
4.5	Agile manufacturing – Definition , business need	1
4.6	Agile manufacturing - conceptual frame work, characteristics, and generic features	2
4.7	Approaches to enhance ability in manufacturing -	1
4.8	Managing people in agile organization	1
5	Introduction of Enterprise Resource Planning	
5.1	Introduction of enterprise resource planning (ERP)- Concept of Enterprise, ERP Overview - Integrated information system - Myths about ERP – Evolution of ERP	2
5.2	Myths about ERP - Basic ERP concepts - Small, medium and large enterprise vendor solutions	2
5.3	Benefits of ERP implementation, Success and failure factors of ERP implementation	1
5.4	Business intelligence (BI), E-Commerce and E-Business, Business Process Reengineering (BPR)	2
5.5	Data warehousing, Data mining, Online Analytical Processing(OLAP), Product lifecycle management(PLC)	2
5.6	Supply chain management(SCM), Customer relationship management (CRM)	1
5.7	ERP implementation challenges, Emerging trends on ERP	1

MET 307	MACHINE TOOLS AND METROLOGY	CATEGORY	L	T	P	Credits
		PCC	3	1	0	4

Preamble:

To develop knowledge of appropriate process parameters to be used for various machining operations.

Understand the fundamentals of modem quality concepts. Be able to apply statistical techniques.

Understand the principles and operation of precision measurement tools and equipment used in modern manufacturing.

Prerequisite: MET 205Metallurgy and Material Science and PHT 110 Engineering Physics

Course Outcomes - At the end of the course students will be able to

CO 1	Analyze various machining process and calculate relevant quantities such us velocities, forces and powers.
CO 2	Analyze of the tool nomenclature with surface roughness obtainable in each machining processes.
CO 3	Understand the limitations of various machining process with regard to shape formation and surface texture.
CO 4	Demonstrate knowledge of the underlying principles of measurement, as they relate to mechanical measurement, electronic instrumentation, and thermal effects.
CO 5	Get an exposure to advanced measuring devices and machine tool metrology.

Mapping of course outcomes with program outcomes (Minimum requirements)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	3	-	-	-	-	-	-	-		2	1
CO 2	2	3	-	-	-	-	-	-	-	-	2	1
CO 3	2	1	-	2	2	-	-	-	-	-	-	2
CO 4	3	-	2	-	-	-	-	-	-	-	2	2
CO 5	2	-	-	2	3	-	-	-	-	-	-	3

ASSESSMENT PATTERN

Bloom's taxonomy	Continuous Assessment Tests		End Semester Examination (Marks)
	Test 1 (Marks)	Test 11 (Marks)	
Remember	25	25	25
Understand	15	15	15
Apply	30	25	30
Analyze	10	10	10
Evaluate	10	15	10
Create	10	10	10

Mark distribution			
Total Marks	**CIE marks**	**ESE marks**	**ESE duration**
150	50	100	3 Hours

Continuous Internal Evaluation (CIE) Pattern:	
Attendance	10 marks
Regular class work/tutorials/assignments/self learning (Minimum 3 numbers)	15 marks
Continuous Assessment Test(Minimum 2numbers)	25 marks

End semester pattern:-There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions.

Part B contains 2 questions from each module of which student should answer anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

COURSE LEVEL ASSESSMENT QUESTIONS

Course Outcome 1 (CO1) Analyze various machining process and calculate relevant quantities such us velocities, forces and powers.

1. List out various types of Lathe attachment explain
2. Explain the working principle of slotter
3. In a verniercalliper, the main scale reads in millimetres with a least count of 0.1 mm.Ten divisions on the vernier correspond to nine divisions of the main scale. Determine the

leastcount of the calliper.

4. A shaft is manufactured within the specified limits of 30.02 and 29.98 mm. Find the high and low limits of the bush to give a maximum clearance of 0.10 mm and minimum clearance of 0.02 mm.
5. What is the difference between rough grinding and precision grinding?

Course Outcome 2 (CO2): Analysis of the tool nomenclature with surface roughness obtainable in each machining processes.

1. Define the terms 'Cutting speed', 'feed' and 'depth of cut'?
2. How are abrasives selected for grinding operation?
3. Why a coolant used in grinding work?
4. How the grinding wheel is selected for a particular job?
5. Describe the nomenclature of hob.
6. Discuss the significant machining parameters for shaping machine.

Course Outcome 3 (CO3): Understand the limitations of various machining process with regard to shape formation and surface texture.

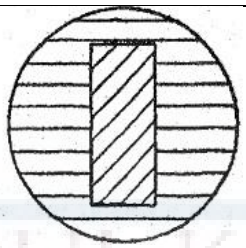
1. What is the difference between drilling, boring and reaming?
2. Explain any three thread production processes.
3. Explain counter sinking and trepanning.
4. Explain different types of gear hobbing machines.
5. Explain planning of guide gibs and slotting of keyways.

Course Outcome 4 (CO4): Students will demonstrate knowledge of the underlying principles of measurement, as they relate to mechanical measurement, electronic instrumentation, and thermal effects.

1. Describe the GO and NOGO gauge design procedure with neat sketch.
2. **Design general type GO and NO GO gauges for a 40H7/d8 fit. 40 mm lies in the diameter range 30 to 50. Show graphically the disposition of gauge tolerance zones relative to the work tolerance zones. Standard tolerance for IT7 is 16i and IT8 is 25i, where 'I' is the standard tolerance unit. The upper deviation for 'd' shaft is $-16D^{0.44}$.**
3. **A 50 mm long pin having diameter 20 ± 0.02 mm, will be electroplated for a thickness of 50 ± 5 μm. Estimate the size of a GO limit gauge, neglecting the gauge to tolerances.**

Course Outcome 5 (CO5): Get an exposure to advanced measuring devices and machine tool metrology.

1. Is assessment length greater/lesser than transverse length in surface roughness measurements? Why?
2. A surface tested under an optical flat using interferometer shows the following interference fringe pattern. Intercept the nature of the surface.



3. What are difference between Rt and Rz with neat sketches
4. How are CMM classified based on their construction? With neat sketches explain the merits and applications any one of them.

MODEL QUESTION PAPER

FIFTH SEMESTER MECHANICAL ENGINEERING

MACHINE TOOLS AND METROLOGY-MET 307

Max. Marks: 100 Duration: 3 Hours
Part – A

Answer all questions.
Answer all questions, each question carries 3 marks

1. What is trepanning? Explain with sketch.
2. What are the use of face plate and angle plate in a lathe?
3. With a sketch, show rake angle of milling cutter and chip breaker.
4. What s the difference between grinding wheel dressing and truing
5. What is the principle of Gear shaping? Explain.
6. Write note on gear errors.
7. Differentiate between precision and accuracy.
8. Explain the process of wringing of slip gauges.
9. Write the importance of cut off length in surface roughness measurement
10. Explain the principle of measurement by light wave interference method.

PART –B

Answer one full question from each module.

MODULE – 1

11. a. What are the attachments used on a center lathe and what purpose do they serve? (7 marks).

b.Draw a drillsignature, name the important angles and explain their each functionand explain plaining of guide gibs(7 marks).

12. Draw sketch of a crank shaper, mark the important parts and explain their functions. Explain how quick return mechanism works. (14 marks).

MODULE – 2

13. a. Explain the principle of working of centreless grinding machine. (7 marks).

b. What are 'Through Feed', 'In Feed', and 'End Feed' in centreless grinding operations? (7 marks).

14. a**.** Explain in detail with neat sketches of a) Slot and groove milling, b) profile milling c) thread milling(7 marks).

b**.** What is the need of better surface finish and how honing, lapping and burnishing process are different in its features and roughness obtainable, explain with sketches. (7 marks).

MODULE – 3

15. Why gear finishing processes are required? Write down the advantages and limitations of gear shaving and gear lapping process with neat sketches. (14 marks).

16 Describe the different methods of manufacturing various types of gears i. Preforming ii. Producing gear teeth by machining iii. Finishing gear teeth (14 marks).

MODULE – 4

17 Discuss all the principles of achieving accuracy. Explain all types of errors. (14 marks).

18. Determine limit dimensions for a clearance fit between mating parts of diameter 40 mm, providing a minimum clearance of 0.10 mm with a tolerance on the hole equal to 0.025mm and on shaft 0.05mm using both systems(14 marks).

MODULE – 5

19 a) Define the following terms in surface texture measurements: -
(i) Primary Texture.(ii) Secondary Texture.(iii) Lay(iv) Sampling Length.(7 marks).

b) Describe the method of evaluating roughness using(i) Peak to valley high method.
(ii) C.L.A. method. (7 marks).

20 a) Discuss the different types of probes used in CMM (7 marks).

b.) Explain the various steps in machine vision system (7 marks).

SYLLABUS

MODULE – 1

General purpose machine tools – types and classification of machine tools –types and classification of lathe – methods of holding work and tool –lathe accessories and attachments –lathe operations -tool room lathe – duplicate lathe –capstan and turret lathe –horizontal and vertical-single spindle and multi spindle screw machines - Shaping, Plaining and Slotting machines – Work holding devices-types of operations - surface roughness obtainable indexing - Drilling and boring Machines – -Drill bit nomenclature- cutting forces in drilling – tool and work holding devices-boring tools and reamers.

MODULE – II

Milling tool nomenclature - Cutting forces in milling – Calculation of machining time- Indexing head Different indexing methods -Grinding, honing and lapping – types of grinding machines-operations: cutting forces in grinding -Grinding mechanisms – Grinding wheels - surface roughness obtainable in grinding, honing and lapping.

MODULE – III

Broaching machines –different machines – cutter for broaching – broaching processes – internal external broaching - Gear cutting –methods in gear production – form cutters –gear generating machines – gear hobbing machines – gear broaching -Bevel gear cutting –worm gear cutting –gear finishing.

MODULE – IV

Metrology –principles of achieving accuracy -Theory of tolerances and allowances –system of limits and fits – types of fits – interchangeability and selective assembly –standards of measurements- Gauges – classification of gauges –principle of gauge tolerance –wear allowance.

MODULE – V

Instruments for checking straightness, flatness and squareness–pneumatic gauging –precision gauging – automatic gauging for inspection-Optical measuring instruments –Comparators –Measurements of surface roughness –- gauging and measurements of screw and gears- Advanced measuring devices – Laser interferometers- Coordinate Measuring Machine (CMM).

Text Books

1. Chapman W. A. J., Workshop Technology, Viva books (P) Ltd
2. HMT, Production Technology, Tata McGraw-Hill
3. Engineering Metrology and Measurements, N.V. Raghavendra, l. Krishnamurthy, oxford university press
4. Galyer J.F.W., Schotbolt C.R., Metrology for Engineers, ELBS.

Reference

1. Acharkan. N., Machine Tool Design Vol. 1 to 4, MIR Publication
2. Chernov, Machine Tools, MIR Publication.
3. HajraChoudary, Elements of workshop technology, Vol I & II, Media Publishers.
4. ASME, Hand book of Industrial Metrology.
5. Hume K. J., Engineering Metrology, Macdonald &Co. Ltd.
6. Sharp K.W.B., Practical Engineering Metrology, Sir Isaac Pitman & Sons Ltd.

COURSE CONTENT AND LECTURE SCHEDULES.

Module	TOPIC	No.of hours	Course outcomes
1.1	General purpose machine tools – types and classification of machine tools –Lathe – types and classification of lathe – specification for a lathe –	1	CO3
	Feed,depth of cut, speed-methods of holding work and tool – lathe accessories and attachments –lathe operations and tools used for each operations -	3	CO1
1.2	Brief study of the machine and the nature and type of jobs handled by the following: - tool room lathe – duplicate lathe – capstan and turret lathe –horizontal and vertical-single spindle and multi spindle screw machines.	3	CO2
1.3	Shaping, Plaining and Slotting machines – Types and specifications – quick return motion –hydraulic feed and its advantages - automatic feed – speed,feed and depth of cut– Work holding devices-types of operations and examples of work done- surface roughness obtainable indexing (Self learning portion, discretion of faculty, fundamentals to be explained in the class)	1	CO3
1.4	Drilling and boring Machines – Types and specifications – Brief descriptions about the machines and nature, types of job	1	CO3

	handled by each of them.		
1.5	-Drill bit nomenclature- cutting forces in drilling – tool and work holding devices-boring tools and reamers.	1	CO2
2.1	Milling machines – types and specifications- Milling operations and types of milling cutters used for each.	1	CO3
2.2	- Milling tool nomenclature - Cutting forces in milling – Calculation of machining time- Indexing head and its use -	1	CO1 CO3
2.3	Different indexing methods - Differential indexing (Self learning portion discretion of faculty, fundamentals to be explained in the class)	1	
2.4	Grinding, honing and lapping – types of grinding machines-operations: cylindrical, surface and center less grinding – internal grinding, tool and cutter grinding - cutting forces in grinding	3	CO1 CO3
2.5	Grinding mechanisms – Grinding wheels: Specification – types of abrasives, grain size -Types of bond, grade, and structure – Marking system of grinding wheels – Selection of grinding wheels –need of better surface finish; surface roughness obtainable in grinding, honing, lapping and burnishing; Surface roughness comparisons between different conventional metal cutting processes.	3	CO3
3.1	Broaching machines –different machines – cutter for broaching – different broaching processes – internal external broaching.	3	CO3
3.2	Gear cutting –methods used in gear production – form cutters – gear generating machines – gear hobbing machines – gear broaching.	3	CO3
3.3	Bevel gear cutting – straight and spiral gears-worm gear cutting –gear finishing operations.	3	CO3
4.1	Metrology –principles of achieving accuracy –economic machining accuracy – precision Vs accuracy - errors- standards of measurements-	2	CO 4
4.2	Theory of tolerances and allowances –system of limits and fits – types of fits – interchangeability and selective assembly – Taylor's Principle-	4	CO 4
4.3	Gauges – classification of gauges- plug, ring, taper angle, slip and snap gauges –feeler gauges-dial indicator –principle of gauge tolerance –wear allowance-gauge materials.	4	CO 4 CO 5
5.1	Instruments for checking straightness, angle, flatness and squareness of guiding surface(Self learning portion, discretion of faculty, fundamentals to be explained in the class). – pneumatic gauging –precision gauging –automatic gauging for inspection.	2	CO 4 CO 5

5.2	Optical measuring instruments, baisc principle – interferometer-optical flat –optical tool makers' microscope-autocollimator.	2	CO 5
5.3	Comparators – mechanical, optical, pneumatic, electric and electronic comparators. (Self learning portion, discretion of faculty, fundamentals to be explained in the class).	1	CO 4
5.4	Measurements of surface roughness – elements of roughness – symbols specifying –instruments and for measuring surface roughness-	1	CO 4
	Measurements of screw: terminology, measurement of screw thread elements-measurement of gears: terminology, errors in spur gears, measurement of gear elements.	2	
5.5	Advanced measuring devices – Laser interferometers-Coordinate Measuring Machine (CMM)	1	CO 5

HUT 300	Industrial Economics & Foreign Trade	Category	L	T	P	CREDIT
		HSMC	3	0	0	3

Preamble: To equip the students to take industrial decisions and to create awareness of economic environment.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Explain the problem of scarcity of resources and consumer behaviour, and to evaluate the impact of government policies on the general economic welfare. (Cognitive knowledge level: **Understand**)
CO2	Take appropriate decisions regarding volume of output and to evaluate the social cost of production. (Cognitive knowledge level: **Apply**)
CO3	Determine the functional requirement of a firm under various competitive conditions. (Cognitive knowledge level: **Analyse**)
CO4	Examine the overall performance of the economy, and the regulation of economic fluctuations and its impact on various sections in the society. (Cognitive knowledge level: **Analyse**)
CO5	Determine the impact of changes in global economic policies on the business opportunities of a firm. (Cognitive knowledge level: **Analyse**)

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2										3	
CO2	2	2			2	2	3				3	
CO3	2	2	1								3	
CO4	2	2	1			1					3	
CO5	2	2	1								3	

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Lifelong learning

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**		**End Semester Examination Marks**
	Test 1 (Marks)	**Test 2 (Marks)**	
Remember	**15**	**15**	**30**
Understand	**20**	**20**	**40**
Apply	**15**	**15**	**30**

Mark Distribution

Total Marks	**CIE Marks**	**ESE Marks**	**ESE Duration**
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance	: 10 marks
Continuous Assessment - Test (2 numbers)	: 25 marks
Continuous Assessment - Assignment	: 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B.

Part A	: 30 marks
Part B	: 70 marks

Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 3 sub-divisions and carries 14 marks.

SYLLABUS

HUT 300 Industrial Economics & Foreign Trade

Module 1 (Basic Concepts and Demand and Supply Analysis)

Scarcity and choice - Basic economic problems- PPC – Firms and its objectives – types of firms – Utility – Law of diminishing marginal utility – Demand and its determinants – law of demand – elasticity of demand – measurement of elasticity and its applications – Supply, law of supply and determinants of supply – Equilibrium – Changes in demand and supply and its effects – Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.

Module 2 (Production and cost)

Production function – law of variable proportion – economies of scale – internal and external economies – Isoquants, isocost line and producer's equilibrium – Expansion path – Technical progress and its implications – Cobb-Douglas production function - Cost concepts – Social cost: private cost and external cost – Explicit and implicit cost – sunk cost - Short run cost curves - long run cost curves – Revenue (concepts) – Shutdown point – Break-even point.

Module 3 (Market Structure)

Perfect and imperfect competition – monopoly, regulation of monopoly, monopolistic completion (features and equilibrium of a firm) – oligopoly – Kinked demand curve – Collusive oligopoly (meaning) – Non-price competition – Product pricing – Cost plus pricing – Target return pricing – Penetration pricing – Predatory pricing – Going rate pricing – Price skimming.

Module 4 (Macroeconomic concepts)

Circular flow of economic activities – Stock and flow – Final goods and intermediate goods - Gross Domestic Product - National Income – Three sectors of an economy- Methods of measuring national income – Inflation- causes and effects – Measures to control inflation- Monetary and fiscal policies – Business financing- Bonds and shares -Money market and Capital market – Stock market – Demat account and Trading account - SENSEX and NIFTY.

Module 5 (International Trade)

Advantages and disadvantages of international trade - Absolute and Comparative advantage theory - Heckscher - Ohlin theory - Balance of payments – Components – Balance of Payments

deficit and devaluation – Trade policy – Free trade versus protection – Tariff and non-tariff barriers.

Reference Materials

1. Gregory N Mankiw, 'Principles of Micro Economics', Cengage Publications
2. Gregory N Mankiw, 'Principles of Macro Economics', Cengage Publications
3. Dwivedi D N, 'Macro Economics', Tata McGraw Hill, New Delhi.
4. Mithani D M, 'Managerial Economics', Himalaya Publishing House, Mumbai.
5. Francis Cherunilam, 'International Economics', McGraw Hill, New Delhi.

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Why does the problem of choice arise?
2. What are the central problems?
3. How do we solve the basic economic problems?
4. What is the relation between price and demand?
5. Explain deadweight loss due to the imposition of a tax.

Course Outcome 2 (CO2):

1. What is shutdown point?
2. What do you mean by producer equilibrium?
3. Explain break-even point;
4. Suppose a chemical factory is functioning in a residential area. What are the external costs?

Course Outcome 3 (CO3):

1. Explain the equilibrium of a firm under monopolistic competition.
2. Why is a monopolist called price maker?
3. What are the methods of non-price competition under oligopoly?

4. What is collusive oligopoly?

Course Outcome 4 (CO4):

1. What is the significance of national income estimation?
2. How is GDP estimated?
3. What are the measures to control inflation?
4. How does inflation affect fixed income group and wage earners?

Course Outcome 5 (CO5):

1. What is devaluation?
2. Suppose a foreign country imposes a tariff on Indian goods. How does it affect India's exports?
3. What is free trade?
4. What are the arguments in favour of protection?

Model Question paper

QP CODE: **PAGES:3**

Reg No:_____ **Name :_____**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY FIFTH /SIXTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 300

Course Name: Industrial Economics & Foreign Trade

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. Why does an economic problem arise?

2. What should be the percentage change in price of a product if the sale is to be increased by 50 percent and its price elasticity of demand is 2?

3. In the production function Q= $2L^{1/2}K^{1/2}$ if L=36 how many units of capital are needed to produce 60 units of output?

4. Suppose in the short run AVC 4. Suppose in the short run AVC<P<AC. Will this firm produce or shut down? Give reason.

5. What is predatory pricing?

6. What do you mean by non- price competition under oligopoly?

7. What are the important economic activities under primary sector?

8. Distinguish between a bond and share?

9. What are the major components of balance of payments?

10. What is devaluation? **(10 x 3 = 30 marks)**

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Prepare a utility schedule showing units of consumption, total utility and marginal utility, and explain the law of diminishing marginal utility. Point out any three limitations of the law.

    b) How is elasticity of demand measured according to the percentage method? How is the measurement of elasticity of demand useful for the government?

Or

12. a) Explain the concepts consumer surplus and producer surplus.

    b) Suppose the government imposes a tax on a commodity where the tax burden met by the consumers. Draw a diagram and explain dead weight loss. Mark consumer surplus, producer surplus, tax revenue and dead weight loss in the diagram.

MODULE II

13. a) What are the advantages of large-scale production?

    b) Explain Producer equilibrium with the help of isoquants and isocost line. What is expansion path?

Or

14. a) Explain break-even analysis with the help of a diagram.

    b) Suppose the monthly fixed cost of a firm is Rs. 40000 and its monthly total variable cost is Rs. 60000.

    i. If the monthly sales is Rs. 120000 estimate contribution and break-even sales.
    ii. If the firm wants to get a monthly profit of Rs.40000, what should be the sales?

    c) The total cost function of a firm is given as $TC=100+50Q - 11Q^2+Q^3$. Find marginal cost when output equals 5 units.

MODULE III

15. a) What are the features of monopolistic competition?

b) Explain the equilibrium of a firm earning supernormal profit under monopolistic competition.

Or

16. a) Make comparison between perfect competition and monopoly.

b) Explain price rigidity under oligopoly with the help of a kinked demand curve.

MODULE IV

17. a) How is national income estimated under product method and expenditure method?

b) Estimate GDPmp, GNPmp and National income

Private consumption expenditure	= 2000 (in 000 cores)
Government Consumption	= 500
NFIA	= -(300)
Investment	= 800
Net=exports	=700
Depreciation	= 400
Net-indirect tax	= 300

Or

18. a) What are the monetary and fiscal policy measures to control inflation?

b) What is SENSEX?

MODULE V

19. a) What are the advantages of disadvantages of foreign trade?

b) Explain the comparative cost advantage.

Or

20. a) What are the arguments in favour protection?

b) Examine the tariff and non-tariff barriers to international trade.

(5 × 14 = 70 marks)

Teaching Plan

Module 1 (Basic concepts and Demand and Supply Analysis)		**7 Hours**
1.1	Scarcity and choice – Basic economic problems - PPC	1 Hour
1.2	Firms and its objectives – types of firms	1 Hour
1.3	Utility – Law of diminishing marginal utility – Demand – law of demand	1 Hour
1.4	Measurement of elasticity and its applications	1 Hour
1.5	Supply, law of supply and determinants of supply	1 Hour
1.6	Equilibrium – changes in demand and supply and its effects	1 Hour
1.7	Consumer surplus and producer surplus (Concepts) – Taxation and deadweight loss.	1 Hour
Module 2 (Production and cost)		**7 Hours**
2.1	Productions function – law of variable proportion	1 Hour
2.2	Economies of scale – internal and external economies	1 Hour
2.3	producers equilibrium – Expansion path	1 Hour
2.4	Technical progress and its implications – cob Douglas Production function	1 Hour
2.5	Cost concepts – social cost: private cost and external cost – Explicit and implicit cost – sunk cost	1 Hour
2.6	Short run cost curves & Long run cost curves	1 Hour
2.7	Revenue (concepts) – shutdown point – Break-even point.	1 Hour
Module 3 (Market Structure)		**6 hours**
3.1	Equilibrium of a firm, MC – MR approach and TC – TR approach	1 Hour
3.2	Perfect competition & Imperfect competition	1 Hour
3.3	Monopoly – Regulation of monopoly – Monopolistic competition	1 Hour
3.4	Oligopoly – kinked demand curve	1 Hour
3.5	Collusive oligopoly (meaning) – Non price competition	1 Hour
3.6	Cost plus pricing – Target return pricing – Penetration, Predatory pricing – Going rate pricing – price skimming	1 Hour

Module 4 (Macroeconomic concepts)		7 Hours
4.1	Circular flow of economic activities	1 Hour
4.2	Stock and flow – Final goods and intermediate goods – Gross Domestic Product - National income – Three sectors of an economy	1 Hour
4.3	Methods of measuring national income	1 Hour
4.4	Inflation – Demand pull and cost push – Causes and effects	1 Hour
4.5	Measures to control inflation – Monetary and fiscal policies	1 Hour
4.6	Business financing – Bonds and shares – Money market and capital market	1 Hour
4.7	Stock market – Demat account and Trading account – SENSEX and NIFTY	1 Hour
Module 5 (International Trade)		**8 Hours**
5.1	Advantages and disadvantages of international trade	1 Hour
5.2	Absolute and comparative advantage theory	2 Hour
5.3	Heckscher – Ohlin theory	1 Hour
5.4	Balance of payments - components	1 Hour
5.5	Balance of payments deficit and devaluation	1 Hour
5.6	Trade policy – Free trade versus protection	1 Hour
5.7	Tariff and non tariff barriers.	1 Hour

HUT 310	Management for Engineers	Category	L	T	P	Credit
		HMC	3	0	0	3

Preamble: This course is intended to help the students to learn the basic concepts and functions of management and its role in the performance of an organization and to understand various decision-making approaches available for managers to achieve excellence. Learners shall have a broad view of different functional areas of management like operations, human resource, finance and marketing.

Prerequisite: Nil

Course Outcomes After the completion of the course the student will be able to

CO1	Explain the characteristics of management in the contemporary context (Cognitive Knowledge level: **Understand**).
CO2	Describe the functions of management (Cognitive Knowledge level: **Understand**).
CO3	Demonstrate ability in decision making process and productivity analysis (Cognitive Knowledge level: **Understand**).
CO4	Illustrate project management technique and develop a project schedule (Cognitive Knowledge level: **Apply**).
CO5	Summarize the functional areas of management (Cognitive Knowledge level: **Understand**).
CO6	Comprehend the concept of entrepreneurship and create business plans (Cognitive Knowledge level: **Understand**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**				**1**	**2**	**2**	**2**		**2**	**1**	**1**
CO2	**2**				**1**	**1**		**2**	**1**	**2**	**1**	**1**
CO3	**2**	**2**	**2**	**2**	**1**							
CO4	**2**	**2**	**2**	**2**	**1**						**2**	**1**
CO5	**2**					**1**	**1**		**1**	**2**	**1**	
CO6		**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Abstract POs defined by National Board of Accreditation			
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	**Test 1 (Marks in percentage)**	**Test 2 (Marks in percentage)**	**End Semester Examination (Marks in percentage)**
Remember	15	15	30
Understand	15	15	30
Apply	20	20	40
Analyse			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	50	100	3 Hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A. Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

HUT 310 Management for Engineers (35 hrs)

Module 1 (Introduction to management Theory- 7 Hours)

Introduction to management theory, Management Defined, Characteristic of Management, Management as an art-profession, System approaches to Management, Task and Responsibilities of a professional Manager, Levels of Manager and Skill required.

Module 2 (management and organization- 5 hours)

Management Process, Planning types , Mission, Goals, Strategy, Programmes, Procedures, Organising, Principles of Organisation, Delegation, Span of Control, Organisation Structures, Directing, Leadership, Motivation, Controlling..

Module 3 (productivity and decision making- 7 hours)

Concept of productivity and its measurement; Competitiveness; Decision making process; decision making under certainty, risk and uncertainty; Decision trees; Models of decision making.

. Module 4 (project management- 8 hours)

Project Management, Network construction, Arrow diagram, Redundancy. CPM and PERT Networks, Scheduling computations, PERT time estimates, Probability of completion of project, Introduction to crashing.

Module 5 (functional areas of management- 8 hours)

Introduction to functional areas of management, Operations management, Human resources management, Marketing management, Financial management, Entrepreneurship, Business plans, Corporate social responsibility, Patents and Intellectual property rights.

References:

1. H. Koontz, and H. Weihrich, Essentials of Management: An International Perspective. 8th ed., McGraw-Hill, 2009.
2. P C Tripathi and P N Reddy, Principles of management, TMH, 4th edition, 2008.
3. P. Kotler, K. L. Keller, A. Koshy, and M. Jha, Marketing Management: A South Asian Perspective. 14th ed., Pearson, 2012.
4. M. Y. Khan, and P. K. Jain, Financial Management, Tata-McGraw Hill, 2008.
5. R. D. Hisrich, and M. P. Peters, Entrepreneurship: Strategy, Developing, and Managing a New Enterprise, 4th ed., McGraw-Hill Education, 1997.
6. D. J. Sumanth, Productivity Engineering and Management, McGraw-Hill Education, 1985.
7. K.Ashwathappa, 'Human Resources and Personnel Management', TMH, 3 rd edition, 2005.
8. R. B. Chase, Ravi Shankar and F. R. Jacobs, Operations and Supply Chain Management, 14th ed. McGraw Hill Education (India), 2015.

Sample Course Level Assessment Questions

Course Outcome1 (CO1): Explain the systems approach to management?

Course Outcome 2 (CO2): Explain the following terms with a suitable example Goal, Objective, and Strategy.

Course Outcome 3 (CO3): Mr. Shyam is the author of what promises to be a successful novel. He has the option to either publish the novel himself or through a publisher. The publisher is offering Mr. Shyam Rs. 20,000 for signing the contract. If the novel is successful, it will sell 200,000 copies. Else, it will sell 10,000 copies only. The publisher pays a Re. 1 royalty per copy. A market survey indicates that there is a 70% chance that the novel will be successful. If Mr. Shyam undertakes publishing, he will incur an initial cost of Rs. 90,000 for printing and marketing., but each copy sold will net him Rs. 2. Based on the given information and the

decision analysis method, determine whether Mr. Shyam should accept the publisher's offer or publish the novel himself.

Course Outcome 4 (CO4): Explain the concepts of crashing and dummy activity in project management.

Course Outcome 5 (CO5): Derive the expression for the Economic order quantity (EOQ)?

Course Outcome 6 (CO6): Briefly explain the theories of Entrepreneurial motivation.?

Model Question Paper

QP CODE: PAGES: 4

Reg No:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FOURTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: HUT 310

Course name: Management for Engineers

Max Marks: 100 **Duration: 3 Hours**

PART-A (Answer All Questions. Each question carries 3 marks)

1. "Management is getting things done through other." Elaborate.

2. Comment on the true nature of management. Is it a science or an art?

3. Planning is looking ahead and controlling is looking back. Comment with suitable examples

4. Explain the process of communication?

5. Explain the hierarchy of objectives?

6. Explain the types of decisions?

7. Describe the Economic man model?

8. Explain the concepts of crashing and dummy activity in project management.

9. Differentiate the quantitative and qualitative methods in forecasting.

10. What are the key metrics for sustainability measurement? What makes the measurement and reporting of sustainability challenging?

PART-B (Answer any one question from each module)

11. a) Explain the systems approach to management. **(10)**

b) Describe the roles of a manager **(4)**

OR

12. a) Explain the 14 principles of administrative management? **(10)**

b) Explain the different managerial skills (**4)**

13. a) What are planning premises, explain the classification of planning premises. **(10)**

b) Distinguish between strategy and policy. How can policies be made effective. **(4)**

OR

14 a) Explain three motivational theories. **(9)**

b) Describe the managerial grid. **(5)**

15. a) Modern forest management uses controlled fires to reduce fire hazards and to stimulate new forest growth. Management has the option to postpone or plan a burning. In a specific forest tract, if burning is postponed, a general administrative cost of Rs. 300 is incurred. If a controlled burning is planned, there is a 50% chance that good weather will prevail and burning will cost Rs. 3200. The results of the burning may be either successful with probability 0.6 or marginal with probability 0.4. Successful execution will result in an estimated benefit of Rs. 6000, and marginal execution will provide only Rs. 3000 in benefits. If the weather is poor, burning will be cancelled incurring a cost of Rs. 1200 and no benefit. i) Develop a decision tree for the problem. (ii) Analyse the decision tree and determine the optimal course of action. **(8)**

b) Student tuition at ABC University is $100 per semester credit hour. The Education department supplements the university revenue by matching student tuition, dollars per dollars. Average class size for typical three credit course is 50 students. Labour costs are $4000 per class, material costs are $20 per student, and overhead cost are $25,000 per class. (a) Determine the total factor productivity. (b) If instructors deliver lecture 14 hours per week and the semester lasts for 16 weeks, what is the labour productivity? **(6)**

OR

16. a) An ice-cream retailer buys ice cream at a cost of Rs. 13 per cup and sells it for Rs. 20 per cup; any remaining unsold at the end of the day, can be disposed at a salvage price of Rs. 2.5 per cup. Past sales have ranged between 13 and 17 cups per day; there is no reason to believe that

sales volume will take on any other magnitude in future. Find the expected monetary value and EOL, if the sales history has the following probabilities: **(9)**

Market Size	13	14	15	16	17
Probability	0.10	0.15	0.15	0.25	0.35

b) At Modem Lumber Company, Kishore the president and a producer of an apple crates sold to growers, has been able, with his current equipment, to produce 240 crates per 100 logs. He currently purchases 100 logs per day, and each log required 3 labour hours to process. He believes that he can hire a professional buyer who can buy a better quality log at the same cost. If this is the case, he increases his production to 260 crates per 100 logs. His labour hours will increase by 8 hours per day. What will be the impact on productivity (measured in crates per labour-hour) if the buyer is hired? What is the growth in productivity in this case? **(5)**

17. a) A project has the following list of activities and time estimates:

Activity	**Time (Days)**	**Immediate Predecessors**
A	1	-
B	4	A
C	3	A
D	7	A
E	6	B
F	2	C, D
G	7	E, F
H	9	D
I	4	G, H

(a) Draw the network. (b) Show the early start and early finish times. (c) Show the critical path. **(10)**

b) An opinion survey involves designing and printing questionnaires, hiring and training personnel, selecting participants, mailing questionnaires and analysing data. Develop the precedence relationships and construct the project network. **(4)**

OR

18. a) The following table shows the precedence requirements, normal and crash times, and normal and crash costs for a construction project:

Activity	Immediate Predecessors	Required Time (Weeks)		Cost (Rs.)	
		Normal	Crash	Normal	Crash
A	-	4	2	10,000	11,000
B	A	3	2	6,000	9,000
C	A	2	1	4,000	6,000
D	B	5	3	14,000	18,000
E	B, C	1	1	9,000	9,000
F	C	3	2	7,000	8,000
G	E, F	4	2	13,000	25,000
H	D, E	4	1	11,000	18,000
I	H, G	6	5	20,000	29,000

Draw the network. (b) Determine the critical path. (c) Determine the optimal duration and the associated cost. **(10)**

b) Differentiate between CPM and PERT. **(4)**

19. a) What is meant by market segmentation and explain the process of market segmentation **(8)**

b) The Honda Co. in India has a division that manufactures two-wheel motorcycles. Its budgeted sales for Model G in 2019 are 80,00,000 units. Honda's target ending inventory is 10,00, 000 units and its beginning inventory is 12, 00, 000 units. The company's budgeted selling price to its distributors and dealers is Rs. 40, 000 per motorcycle. Honda procures all its wheels from an

outside supplier. No defective wheels are accepted. Honda's needs for extra wheels for replacement parts are ordered by a separate division of the company. The company's target ending inventory is 3,00,000 wheels and its beginning inventory is 2,00,000 wheels. The budgeted purchase price is Rs. 1,600 per wheel.

(a) Compute the budgeted revenue in rupees.

(b) Compute the number of motorcycles to be produced.

Compute the budgeted purchases of wheels in units and in rupees.? **(6)**

OR

20. a) a) "Human Resource Management policies and principles contribute to effectiveness, continuity and stability of the organization". Discuss. (b) What is a budget? Explain how sales budget and production budgets are prepared? **(10)**

b) Distinguish between the following: (a) Assets and Liabilities (b) Production concept and Marketing concept (c) Needs and Wants (d) Design functions and Operational control functions in operations **(4)**

Teaching Plan

Sl.No	TOPIC	SESSION
	Module I	
1.1	Introduction to management	1
1.2	Levels of managers and skill required	2
1.3	Classical management theories	3
1.4	neo-classical management theories	4
1.5	modern management theories	5
1.6	System approaches to Management,	6
1.7	Task and Responsibilities of a professional Manager	7
	Module 2	
2.1	Management process – planning	8
2.2	Mission – objectives – goals – strategy – policies – programmes – procedures	9
2.3	Organizing, principles of organizing, organization structures	10
2.4	Directing, Leadership	11
2.5	Motivation, Controlling	12
	Module III	
3.1	Concept of productivity and its measurement Competitiveness	13
3.2	Decision making process;	14
3.3	Models in decision making	15
3.4	Decision making under certainty and risk	16
3.5	Decision making under uncertainty	17
3.6	Decision trees	18
3.7	Models of decision making.	19
	Module IV	
4.1	Project Management	20

Sl.No	TOPIC	SESSION
	Module I	
4.2	Network construction	21
4.3	Arrow diagram, Redundancy	22
4.4	CPM and PERT Networks	23
4.5	Scheduling computations	24
4.6	PERT time estimates	25
4.7	Probability of completion of project	26
4.8	Introduction to crashing	
	Module V	
5.1	Introduction to functional areas of management,	28
5.2	Operations management	29
5.3	Human resources management ,	30
5.4	Marketing management	31
5.5	Financial management	32
5.6	Entrepreneurship,	33
5.7	Business plans	34
5.8	Corporate social responsibility, Patents and Intellectual property rights	35

MCN 301	DISASTER MANAGEMENT	Category	L	T	P	CREDIT	YEAR OF INTRODUCTION
		Non - Credit	2	0	0	Nil	2019

Preamble: The objective of this course is to introduce the fundamental concepts of hazards and disaster management.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO1	Define and use various terminologies in use in disaster management parlance and organise each of these terms in relation to the disaster management cycle (Cognitive knowledge level: **Understand**).
CO2	Distinguish between different hazard types and vulnerability types and do vulnerability assessment (Cognitive knowledge level: **Understand**).
CO3	Identify the components and describe the process of risk assessment, and apply appropriate methodologies to assess risk (Cognitive knowledge level: **Understand**).
CO4	Explain the core elements and phases of Disaster Risk Management and develop possible measures to reduce disaster risks across sector and community (Cognitive knowledge level: **Apply**)
CO5	Identify factors that determine the nature of disaster response and discuss the various disaster response actions (Cognitive knowledge level: **Understand**).
CO6	Explain the various legislations and best practices for disaster management and risk reduction at national and international level (Cognitive knowledge level: **Understand**).

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO1 0	PO1 1	PO1 2
CO1		2				2				2		2
CO2	2	3	2		2	2	3			3		2
CO3	2	3	2	2	2	2	3			3		2
CO4	3	3	3		2	2	3					2
CO5	3	3			2	2	3					2
CO6	3					2	3	3				2

Abstract POs defined by National Board of Accreditation			
PO#	**Broad PO**	**PO#**	**Broad PO**
PO1	Engineering Knowledge	PO7	Environment and Sustainability
PO2	Problem Analysis	PO8	Ethics
PO3	Design/Development of solutions	PO9	Individual and team work
PO4	Conduct investigations of complex problems	PO10	Communication
PO5	Modern tool usage	PO11	Project Management and Finance
PO6	The Engineer and Society	PO12	Life long learning

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination Marks
	Test 1 (Marks)	Test 2 (Marks)	
Remember	**10**	**10**	**20**
Understand	**25**	**25**	**50**
Apply	**15**	**15**	**30**
Analyze			
Evaluate			
Create			

Mark Distribution

Total Marks	CIE Marks	ESE Marks	ESE Duration
150	**50**	**100**	**3 hours**

Continuous Internal Evaluation Pattern:

Attendance : 10 marks

Continuous Assessment - Test : 25 marks

Continuous Assessment - Assignment : 15 marks

Internal Examination Pattern:

Each of the two internal examinations has to be conducted out of 50 marks. First series test shall be preferably conducted after completing the first half of the syllabus and the second series test shall be preferably conducted after completing remaining part of the syllabus. There will be two parts: Part A and Part B. Part A contains 5 questions (preferably, 2 questions each from the completed modules and 1 question from the partly completed module), having 3 marks for each question adding up to 15 marks for part A. Students should answer all questions from Part A.

Part B contains 7 questions (preferably, 3 questions each from the completed modules and 1 question from the partly completed module), each with 7 marks. Out of the 7 questions, a student should answer any 5.

End Semester Examination Pattern:

There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which a student should answer any one. Each question can have maximum 2 sub-divisions and carries 14 marks.

SYLLABUS

MCN 301 Disaster Management

Module 1

Systems of earth

Lithosphere- composition, rocks, soils; Atmosphere-layers, ozone layer, greenhouse effect, weather, cyclones, atmospheric circulations, Indian Monsoon; hydrosphere- Oceans, inland water bodies; biosphere

Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard, exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, disaster risk management, early warning systems, disaster preparedness, disaster prevention, disaster mitigation, disaster response, damage assessment, crisis counselling, needs assessment.

Module 2

Hazard types and hazard mapping; Vulnerability types and their assessment- physical, social, economic and environmental vulnerability.

Disaster risk assessment –approaches, procedures

Module 3

Disaster risk management -Core elements and phases of Disaster Risk Management

Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness.

Disaster response- objectives, requirements; response planning; types of responses.

Relief; international relief organizations.

Module 4

Participatory stakeholder engagement; Disaster communication- importance, methods, barriers; Crisis counselling

Capacity Building: Concept – Structural and Non-structural Measures, Capacity Assessment; Strengthening Capacity for Reducing Risk

Module 5

Common disaster types in India; Legislations in India on disaster management; National disaster management policy; Institutional arrangements for disaster management in India.

The Sendai Framework for Disaster Risk Reduction- targets, priorities for action, guiding principles

Reference Text Book

1. R. Subramanian, Disaster Management, Vikas Publishing House, 2018
2. M. M. Sulphey, Disaster Management, PHI Learning, 2016
3. UNDP, Disaster Risk Management Training Manual, 2016
4. United Nations Office for Disaster Risk Reduction, Sendai Framework for Disaster Risk Reduction 2015-2030, 2015

Sample Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the mechanism by which stratospheric ozone protects earth from harmful UV rays?
2. What are disasters? What are their causes?
3. Explain the different types of cyclones and the mechanism of their formation
4. Explain with examples, the difference between hazard and risk in the context of disaster management
5. Explain the following terms in the context of disaster management (a) exposure (b) resilience (c) disaster risk management (d) early warning systems, (e) damage assessment (f) crisis counselling (g) needs assessment

Course Outcome 2 (CO2):

1. What is hazard mapping? What are its objectives?
2. What is participatory hazard mapping? How is it conducted? What are its advantages?
3. Explain the applications of hazard maps
4. Explain the types of vulnerabilities and the approaches to assess them

Course Outcome 3 (CO3):

1. Explain briefly the concept of ‘disaster risk’

2. List the strategies for disaster risk management ‘before’, ‘during’ and ‘after’ a disaster
3. What is disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy

Course Outcome 4 (CO4):

1. What is disaster prevention? Distinguish it from disaster mitigation giving examples
2. What are the steps to effective disaster communication? What are the barriers to communication?
3. Explain capacity building in the context of disaster management

Course Outcome 5 (CO5):

1. Briefly explain the levels of stakeholder participation in the context of disaster risk reduction
2. Explain the importance of communication in disaster management
3. Explain the benefits and costs of stakeholder participation in disaster management
4. How are stakeholders in disaster management identified?

Course Outcome 6 (CO6):

1. Explain the salient features of the National Policy on Disaster Management in India
2. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction
3. What are Tsunamis? How are they caused?
4. Explain the earthquake zonation of India

Model Question paper

QP CODE: **PAGES:3**

Reg No:_____ **Name :_____**

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: MCN 301

Course Name: Disaster Management

Max.Marks:100 **Duration: 3 Hours**

PART A

Answer all Questions. Each question carries 3 Marks

1. What is the mechanism by which stratospheric ozone protects earth from harmful UV rays?
2. What are disasters? What are their causes?
3. What is hazard mapping? What are its objectives?
4. Explain briefly the concept of 'disaster risk'
5. List the strategies for disaster risk management 'before', 'during' and 'after' a disaster
6. What is disaster prevention? Distinguish it from disaster mitigation giving examples
7. Briefly explain the levels of stakeholder participation in the context of disaster risk reduction
8. Explain the importance of communication in disaster management
9. What are Tsunamis? How are they caused?
10. Explain the earthquake zonation of India

Part B

Answer any one Question from each module. Each question carries 14 Marks

11. a. Explain the different types of cyclones and the mechanism of their formation [10]

b. Explain with examples, the difference between hazard and risk in the context of disaster management
[4]

OR

12. Explain the following terms in the context of disaster management [14]

(a) exposure (b) resilience (c) disaster risk management (d) early warning systems, (e) damage assessment (f) crisis counselling (g) needs assessment

13. a. What is participatory hazard mapping? How is it conducted? What are its advantages?

[8]

b. Explain the applications of hazard maps [6]

OR

14. Explain the types of vulnerabilities and the approaches to assess them [14]

15. a. Explain the core elements of disaster risk management [8]

b. Explain the factors that decide the nature of disaster response [6]

OR

16. a. What is disaster preparedness? Explain the components of a comprehensive disaster preparedness strategy [6]

b. Explain the different disaster response actions [8]

17. a. Explain the benefits and costs of stakeholder participation in disaster management [10]

b. How are stakeholders in disaster management identified? [4]

OR

18. a. What are the steps to effective disaster communication? What are the barriers to communication? [7]

b. Explain capacity building in the context of disaster management [7]

19. Explain the salient features of the National Policy on Disaster Management in India

[14]

OR

20. Explain the guiding principles and priorities of action according to the Sendai Framework for Disaster Risk Reduction [14]

Teaching Plan

	Module 1	**5 Hours**
1.1	Introduction about various Systems of earth, Lithosphere-composition, rocks, Soils; Atmosphere-layers, ozone layer, greenhouse effect, weather	1 Hour
1.2	Cyclones, atmospheric circulations, Indian Monsoon; hydrosphere-Oceans, inland water bodies; biosphere	1 Hour
1.3	Definition and meaning of key terms in Disaster Risk Reduction and Management- disaster, hazard,	1 Hour
1.4	Exposure, vulnerability, risk, risk assessment, risk mapping, capacity, resilience, disaster risk reduction, Disaster risk management, early warning systems	1 Hour
1.5	Disaster preparedness, disaster prevention, disaster, Mitigation, disaster response, damage assessment, crisis counselling, needs assessment.	1 Hour
	Module 2	**5 Hours**
2.1	Various Hazard types, Hazard mapping; Different types of Vulnerability types and their assessment	1 Hour
2.2	Vulnerability assessment and types, Physical and social vulnerability	1 Hour
2.3	Economic and environmental vulnerability, Core elements of disaster risk assessment	1 Hour
2.4	Components of a comprehensive disaster preparedness strategy approaches, procedures	1 Hour
2.5	Different disaster response actions	1 Hour
	Module 3	**5 Hours**
3.1	Introduction to Disaster risk management, Core elements of Disaster Risk Management	1 Hour
3.2	Phases of Disaster Risk Management, Measures for Disaster Risk Reduction	1 Hour
3.3	Measures for Disaster prevention, mitigation, and preparedness.	1 Hour

3.4	Disaster response- objectives, requirements. Disaster response planning; types of responses.	1 Hour
3.5	Introduction- Disaster Relief, Relief; international relief organizations.	1 Hour
	Module 4	**5 Hours**
4.1	Participatory stakeholder engagement	1 Hour
4.2	Importance of disaster communication.	1 Hour
4.3	Disaster communication- methods, barriers. Crisis counselling	1 Hour
4.4	Introduction to Capacity Building. Concept – Structural Measures, Non-structural Measures.	1 Hour
4.5	Introduction to Capacity Assessment, Capacity Assessment; Strengthening, Capacity for Reducing Risk	1 Hour
	Module 5	**5 Hours**
5.1	Introduction-Common disaster types in India.	1 Hour
5.2	Common disaster legislations in India on disaster management	1 Hour
5.3	National disaster management policy, Institutional arrangements for disaster management in India.	1 Hour
5.4	The Sendai Framework for Disaster Risk Reduction and targets	1 Hour
5.5	The Sendai Framework for Disaster Risk Reduction-priorities for action, guiding principles	1 Hour

CODE	COURSE NAME:	CATEGORY	L	T	P	CREDIT
MEL331	MACHINE TOOLS LAB II	PCC	0	0	3	2

Preamble:

1. To learn the measurement of bores by internal micrometers, bore indicators, indirect methods etc.
2. To learn the measurement of the Angle and taper by Bevel protractor, Sine bars, indirect methods etc.
3. Allow to study the various limits, fits and tolerances adopted in the production drawings.
4. To learn to measure straightness, flatness, roundness, profile, screw threads and gear teeth.
5. To learn, to prepare programs for CNC machines and measurements in CMM.

Course Outcomes - At the end of the course students will be able to

CO 1

Apply the procedures to measure length, angles, width, depth, bore diameters, internal and external tapers, tool angles, and surface roughness by using different instruments and by different indirect methods.

CO 2

Determine limits and fits and allocate tolerances for machine components

CO 3

CNC programming and to use coordinate measuring machine to record measurements of complex profiles with high sensitivity.

CO 4

Use effective methods of measuring straightness, Squareness, flatness, roundness, profile, screw threads and gear teeth.

CO 5

Securing knowledge of manufacturing components within the tolerance limit and surface roughness according to given drawings using various machine tools.

Mapping of course outcomes with program outcomes (Minimum requirements)

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	-	-	-	-	-	-	-	-	-	-	-
CO 2	-	-	3	-	-	-	-	-	-	-	-	-
CO 3	-	-		3	-	-	-	-	-	-	-	-
CO 4	-	3	-	-	-	-	-	-	-	-	-	-
CO 5	-	-	-	-	3	-	-	-	-	-	-	-

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance	:	15 marks
Continuous Assessment	:	30 marks
Internal Test (Immediately before the second series test)	:	30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work	: 15 Marks
(b) Implementing the work/Conducting the experiment	: 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting)	: 25 Marks
(d) Viva voce	: 20 marks
(e) Record	: 5 Marks

General instructions:

Practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

SYLLABUS

Experiments on Grinding machine – Programming and experiments on CNC machines- Uncertainty in metrology and measurement standards - Errors and their impact on the calculation of uncertainties - Measurement types and instrument selection - Geometric features of parts - Measuring straightness, squareness, flatness, roundness, and profile -Screw threads and gear teeth, optical contour projectors - Gage measurement - Surface texture and roughness measurement – flaw detection - Coordinate measuring machine - Modern measuring instruments and machines.

Reference books

1. Yoram Koren, Numerical Control of Machine Tools, McGraw-Hill.
2. Shotbolt C.R. and Gayler J.F.W, Metrology for Engineers, 5th edition, ELBS, London.
3. Sharp K.W.B. and Hume, Practical Engineering Metrology, Sir Isaac Pitman and sons Ltd,

London.

4. Collett, C.V. and Hope, A.D, Engineering Measurements, Second edition, ELBS/Longman

Experiments	List of Experiments	Course outcomes	No. of hours
1	**Programming and experiment on CNC machines** Study and preparation of programme, simulation and exercise on CNC lathe:-turning, step turning, taper turning, thread cutting, ball and cup turning etc.	CO 3	3
2	Study and preparation of programme, simulation and exercise on CNC milling machine: - surface milling, pocket milling, contour milling etc.		3
3	**Experiment on Grinding machine** Exercise on surface grinding, cylindrical grinding and tool grinding etc.	CO 1 CO 5	3
	Measurement of cutting forces and roughness in grinding process and correlate with varying input parameters.		
4	**Basics for mechanical measurements** Calibration of vernier caliper, micrometer and dial gauge. Determination of dimensions of given specimen using vernier caliper, micrometer, height gauge, bore dial gauge etc. Determination of dimensions of a rectangular, square, cylindrical specimens using slip gauges and comparing with height gauge/vernier caliper etc	CO 1 CO 2	3
	Experiments on Limits, Fits and Tolerance Determine the class of fits between given shaft and hole. etc		
5	**Experiments on Repeatability and Reproducibility** Study and analysis of repeatability and reproducibility of given batch of steel balls. etc.	CO 1 CO 2	3
6	**Linear measurements** Study of different linear measuring instruments etc. Calibration of LVDT using slip gauges	CO 1 CO 5	3

7	**Straightness error measurement** Study of different straightness error measuring instruments – basic principle of auto collimator, spirit level and laser interferometer. Measurement of straightness error of a CI surface plate using auto collimator and comparing with sprit level. Laser interferometer used to determine straightness error To check straightness error of a straight edge by the wedge method using slip gauges.	CO 4	3
8	**Angle measurements** Angular measurements using bevel protractor, combination sets, clinometers, angle dekkor etc. Measurement of angle and width of a V-block and comparing with combination sets. Measurement of angle using sine bar of different samples. Determination of angle and taper of a taper plug gauge	CO 1	3
9	**Out of roundness measurement** Study of different methods used for measuring out of roundness Measurement of out of roundness using form measuring instrument Measurement of out of roundness using V-block and dial gauge Measurement of out of roundness using bench centre and dial gauge etc.	CO 4	3
10	**Screw thread measurement** Measurement of screw thread parameters using two wire and three wire method. Measurement of screw thread parameters using tool maker's microscope etc. Measurement of screw thread parameters using thread ring gage, thread plug gage, thread snap gage, screw thread micrometer, optical comparator etc.	CO 4	3
11	**Bore measurement** Measurement of a bore by two ball method. Measurement of a bore by four ball method. Bore measurement using slip gauges and rollers.	CO 1	3

	Bore measurement using bore dial gauge etc.		
12	**Gear metrology** Study of types of gears – gear terminology – gear errors - Profile Projector. Measurement of profile error and gear parameters using profile projector etc. **Use of Comparators** Exercise on comparators: mechanical, optical, pneumatic and electronic comparators.	CO 4	3
13	**Use of Tool maker's microscope** Study of tool maker's microscope – use at shop floor applications. Measurement of gear tooth parameters using tool maker's microscope. Measurement of different angles of single point cutting tool using tool maker's microscope.	CO 1	3
14	**Surface roughness measurement** Measurement of surface roughness using surface profilometer /roughness measuring machine of turned, milled, grounded, lapped and glass etc specimens.	CO 1	3
15	**Squareness measurement** Determination of squareness of a trisquare using angle plate and slip gauges etc.	CO 1	3
16	**Flatness measurement** Study of optical flat and variation of fringe patterns for different surfaces. Determination of parallelism error between micrometer faces etc. Compare given surface using optical flat with interpretation chart**.**	CO 4	3
17	**Vibration measurement** Measurement of displacement, velocity and acceleration of vibration.	CO 5	3

18	**Use of Pneumatic comparator** Checking the limits of dimensional tolerances using pneumatic comparator Calibration using air plug gauge etc	CO 5	3
19	**Rotation measurement** Determination of rpm using tachometer, optical tachometer and stroboscope, etc. **Flaw detection** Study and use of ultrasonic flaw detector.	CO 5	3
20	**Other measurements** Study and making measurements with precision vernier calipers, dial calipers, point micrometer spline micrometer, wire groove micrometer, depth micrometer, V- anvil micrometers, depth gear tooth micrometer, thread micrometer, disc micrometer, thread pitch gauge, vernier height gauge, feeler gauge, three pin micrometer, depth gauge, pitch gauge, thickness gauge, radius gauge, hole test etc. Analysis of automobile exhaust gas and flue gas. Use of feeler gauge to determine the gap of spark plug. Any other modern measuring instruments CMM, EDM, Wire cut EDM,USM etc	CO 5	3

A minimum of 12 sets of experiments are mandatory out of total 20 experiments but both experiments mentioned for programming and experiments on CNC machines are mandatory.

Besides to the skill development in performing the work, oral examination should be conducted during end semester examination.

The student's assessment, continuous evaluation, record bonafides, awarding of sessional marks, oral examination etc. should be carried out by the assistant professor or above.

CODE	COURSE NAME:	CATEGORY	L	T	P	CREDIT
MEL333	THERMAL ENGINEERING LAB 1	PCC	0	0	3	2

Preamble: The course is intended to impart basic understanding on the working of internal combustion engines. This includes various performance tests on internal combustion engines as well as makes the students familiar with the evaluation of fuel properties such as viscosity, flash and fire points, calorific value etc. which are key to any performance test.

Prerequisite: Should have undergone a course on Thermal Engineering with emphasis on IC engines

Course Outcomes: After completion of the course the student will be able to

CO 1	**Measure thermo-physical properties of solid, liquid and gaseous fuels**
CO 2	**Identify various systems and subsystems of Diesel and petrol engines**
CO 3	**Analyse the performance characteristics of internal combustion engines**
CO 4	**Investigate the emission characteristics of exhaust gases from IC Engines**
CO 5	**Interpret the performance characteristics of air compressors / blowers**

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	**3**		2	3			2		3	2		2
CO 2	**3**		2	3			2		3	2		2
CO 3	**3**		2	3			2		3	2		2
CO 4	**3**		2	3			2		3	2		2
CO 5	**3**		2	3			2		3	2		2

Assessment Pattern

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	75	75	2.5 hours

Continuous Internal Evaluation Pattern:

Attendance : 15 marks
Continuous Assessment : 30 marks
Internal Test (Immediately before the second series test) : 30 marks

End Semester Examination Pattern: The following guidelines should be followed regarding award of marks

(a) Preliminary work : 15 Marks
(b) Implementing the work/Conducting the experiment : 10 Marks
(c) Performance, result and inference (usage of equipments and trouble shooting) : 25 Marks
(d) Viva voce : 20 marks
(e) Record : 5 Marks

General instructions:

Practical examination is to be conducted immediately after the second series test covering entire syllabus given below. Evaluation is a serious process that is to be conducted under the equal responsibility of both the internal and external examiners. The number of candidates evaluated per day should not exceed 20. Students shall be allowed for the University examination only on submitting the duly certified record. The external examiner shall endorse the record.

List of Exercises/Experiments: (Lab experiments may be given considering 12 sessions of 3 hours each. Minimum 12 experiments to be performed.)

1. Determination of flash and fire points of petroleum fuels and oils
2. Determination of viscosity of lubricating oils and fuels and its variation with temperature
3. Determination of calorific value of solid and liquid fuels- Bomb Calorimeter
4. Determination of calorific value of gaseous fuels –Gas Calorimeter
5. Familiarisation of various systems and subsystems of petrol engine / MPFI engine
6. Familiarisation of various systems and parts of Diesel engine / Turbocharged engine
7. Performance test on petrol engines / MPFI engine
8. Performance test on Diesel engines / Turbocharged engine
9. Heat Balance test on petrol/Diesel engines
10. Determination volumetric efficiency and Air-fuel ratio of IC engines
11. Cooling curve of IC engines
12. Valve timing diagram of IC engines
13. Economic speed test on IC engines
14. Retardation test on IC engines
15. Morse test on petrol engine
16. Experiment to find flame temperature of premixed flames at different equivalence ratios and temperature of diffusion flames at different fuel flow rates.
17. Analysis of automobile exhaust gas and flue gas using exhaust gas analyser.
18. .Performance test on reciprocating compressor
19. Performance test on rotary compressor/blower

Reference Books

1. J.B.Heywood, I.C engine fundamentals, McGraw-Hill, 2017
2. V. Ganesan, Fundamentals of IC engines, Tata McGraw-Hill, 2017
3. Stephen R Turns, An Introduction to Combustion: Concepts and Applications, McGraw-Hill, 2017