2022-2023 **B. Tech/ Even**

AUTOMOBILE ENGINEERING **2022-2023/ Mid term**

MEE- 610

Full Marks: 25 **Time: 90 minutes**

Figures in the margin indicate full marks

1. Why is single cylinder, two stroke, air-cooled, petrol engine used in two wheelers? 2
2. What is a cylinder liner? What is the difference between a dry liner and wet liner? 2
3. State the purpose of the ventilation and heating system. 2
4. Explain how the compressor clutch works. 2
5. List the visual checks carried out to locate air conditioning troubles. 2
6. Why is a receiver dryer used in the air conditioning system? Explain its operation with a neat sketch. 2.5
7. What are the different emissions from an automobile? Mark them by drawing a sketch of a model automobile. $1.5 + 2 = 3.5$
8. Give composition of tailpipe emission. Brief the effects of each of the type. $2 + 2 = 4$
9. Give list of alternative energy sources which can be used in future for automobiles. 2
10. A petrol engine of a car develops 125 Nm torque at 2700 rpm. The car is driven in second gear having gear ratio of 1.75. The final drive ratio is 4.11. If the overall transmission efficiency is 90%, then find the torque available at the driving wheels. 3

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Mid-term Examination, 2022-23

Course Code: MEE 611 Full Marks: 25

Course Name: Gas Dynamics and Propulsion Time: 1.5 Hours

Question Paper No.: NITDGP/MEE611/ 1

Instructions: **Answer Question no. 1 and any three from the rest.**

Properties of air: R=287 J/kg.K, Cp=1004 J/kg.K

Materials to be supplied: **Gas Table.**

Question No.	Body of the Question	Marks	Mapped CO
1.	In ideal Ramjet Engine, the ambient temperature, T_∞=210K ,Maximum temperature, Tmax=2100K, Fuel used is JP4 whose heating value, Q_R=45000 kJ/kg, (i) Find the Flight Mach Number, M_∞ (Neglecting f) when specific Thrust$(T/\dot{m}_a)$ is maximum. (ii)Find the maximum value of the specific thrust. (iii) Corresponding to the maximum specific thrust, find fuel –air ratio, f approximately. (iv) Find the corresponding Thermal efficiency (η_{th}). (v)Find the TSFC of the engine when specific thrust is maximum.	1.5X4 +1=7	CO4
2.	A converging–diverging nozzle is designed to operate with an Mach number of 2.25. It is fed by a large chamber of air at 116.3 kPa and 400K and exhausts in to the room at 114 kPa. Assuming the losses to be negligible, compute the velocity at the nozzle exit , velocity inthe nozzle throat and the mass flow rate if throat area is $1m^2$.	6	CO1
3.	Air flows through a converging–diverging nozzle designed to operate at a Mach number of 3.0. If it is subjected to an operating pressure ratio of 0.5: (a) Determine the Mach number at the exit. (b) What is the entropy change in the nozzle? (c) Compute the area ratio at the shock location. (d) What value of the operating pressure ratio would be required to move the shock to the exit?	6	CO2
4.	A converging–diverging nozzle has an area ratio of 3.0. The stagnation pressure at the inlet is 8.0 bar and the receiver pressure is 3.5 bar. The fluid is air. (a) Compute the critical operating pressure ratios for the nozzle and show that a shock is located within the diverging section. (b) Compute the Mach number at the outlet. (c) Compute the shock location (area) and the Mach number before the shock.	6	CO2

CO1. **To recall** the fundamentals of compressible flow and thermodynamics of jet propulsion
CO2: **To analyse** the Normal shock, oblique Shock and Prandtl-Meyer Flow, Fanno Flow and Rayleigh Flow.
CO3: **To evaluate** the Lift and Drag of supersonic aerofoils and **to assess** the correlation among Fanno flow, Rayleigh flow, and a normal shock.
CO4: **To Predict** the Performances of Air Breathing and Non Air Breathing Engines (Solid Rocket Motors and Liquid Rocket Engines).

5.	A converging–diverging nozzle receives air from a tank at 100 MPa and 600K. The pressure is 28.0 MPa immediately preceding a plane shock that is located in the diverging section. The Mach number at the exit is 0.5 and the flow rate is 10 kg/s, determine **(a)** The throat area. **(b)** The area at which the shock is located. **(c)** The outlet pressure required to operate the nozzle in the manner described above. **(d)** The outlet area. **(e)** The design Mach number	6	CO2

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester Mid-Term Examination, 2022-23

Course Code: MEE612 Full Marks: 25

Course Name: Mechanics of Forming and Press Working Time: 90 Minutes

Answer all the questions
Assume suitable data, if required

Q. No.	Question	Marks	Mapped CO
1	a) Define 'true strain' and derive mathematical expression for it from the definition.	2	CO1
	b) A solid cube is subjected to a stress σ_x= 50 MPa and σ_y= 30 MPa. Shear stresses on the faces X and Y are zero. (i) What is the maximum in-plane shear stress? What is the direction of action? (ii) What is the maximum absolute shear stress? What is the direction of action?	2	
	c) State and explain Tresca's theory for criterion of failure.	2	
	d) Prove that the value of shear yield stress according to Von Mises is 15.4% greater than that according to Tresca's.	3.5	
	e) Describe 'upsetting' operation in forging with neat sketches.	3	
2	a) Write the classification of press in terms of the structures. Draw a sketch of any one of the structure.	2.5	CO2
	b) What do you mean by bending allowance for sheet bending operations? Write the expression for bending allowance indicating each terms.	2.5	
	c) Show the constructional differences between the stamping die set and the forming die set with appropriate figures.	2.5	
	d) Estimate the minimum force required to bend a 4.6mm thick mild steel sheet (σ_y= 350 MPa) of 3m length with wiping die. The bending radius is same as the thickness of the sheet.	2.5	
	e) Estimate the minimum force required to punch a rectangular hole of 25mm X 40mm size on a 4.6mm thick mild steel sheet (σ_u= 450 MPa) by stamping die.	2.5	

Course Outcomes
CO1: Detailed and in depth analysis of the forming processes.
CO2: Specialized techniques in forming practiced in industry.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester Mid-Term Examination, 2022-23

Course Code: MEE613 Full Marks: 25

Course Name: Advanced Solid Mechanics Time: 90 Minutes

Instructions: Answer six questions. Attempt either question 2 or question 3.

Question No.	Body of the Question	Marks	Mapped CO
1	If A= 2i-6j-3k and B=4i+3j-k, Determine AxB and determine a unit vector perpendicular to the plane of A and B.	4	CO1
2	Determine the principal stresses and direction cosine (for maximum principal stress only) and octahedral shear stress for the state of stress characterized by the following stress matrix. $\begin{bmatrix} 5 & -2 & 0 \\ -2 & 5 & 3 \\ 0 & 3 & 4 \end{bmatrix}$ MPa	5	CO2
	Or		
3	Draw the Mohr's circles for the above state of stress and calculate maximum shear stresses from the Mohr's circles.	5	CO2
4	Derive the equations of equilibrium for Cartesian coordinate system.	5	CO2
5	For paraboloidal coordinate find out the arc length. For paraboloidal coordinate system: $x = u\,v\cos\phi,\ y = u\,v\sin\phi$ and $z = \frac{1}{2}(u^2 - v^2)$	3	CO2
6	Derive the strain compatibility equations from strain displacement relations.	3	CO2
7	A thick walled tube with an internal radius of 10cm is subjected to an internal pressure 2000kgf/cm^2(196000kPa). E=2x10^{6}kgf/cm^2 (196x10^{6}kPa) and ν=0.3. Determine the value of the external radius if the maximum shear stress developed is limited to 3000kgf/cm^2(294x10^{6}kPa). Calculate the change in the internal radius due to the pressure. Consider the problem as plane stress problem.	5	CO3

CO1: Extend their knowledge from vector to tensor, and from isotropic to anisotropic materials
CO2: Apply the knowledge of 3-D state of stress and strain
CO3: Apply the concept of thick cylinder theory
CO4: Apply the energy principles
CO5: Apply the theory of noncircular shaft

Q. No. MEE 621/ 50

B.TECH/EVEN
REG/(22-23)

Even Semester Mid-term Examination, 2022-23

MECHANICS OF COMPOSITE AND FUNCTIONALLY GRADED MATERIALS

MEE 621

Full Marks : 25 *Time* : 90 Minutes

The figures in the margin indicate full marks.

Answer any *three* questions.

1 mark is allotted for overall impression.

Question No.	Body of the Question	Marks	Mapped CO

1. (A) Write the reinforcements and matrix (with examples) in 8 CO1

   (i) Polymers Matrix Composites (PMCs)

   (ii) Metal Matrix Composites (MMCs)

   (iii) Ceramic Matrix Composites (CMCs)

   (iv) Carbon Carbon Composites (CCCs)

   Or

   (B) Define (with examples) the following terminologies

   (i) Homogeneous and non-homogeneous

   (ii) Isotropic and Anisotropic

(iii) Lamina and Laminate

(iv)Local/Material Axes and Global/Analysis/ Loading Axes

2. For a graphite/epoxy unidirectional lamina, find the following 8 CO2

(a) Compliance matrix

(b) Minor Poisson's ratio

(c) Reduced stiffness matrix

(d) Strains in the 1-2 coordinate system if the applied stresses are σ_1 = 20 MPa, σ_2 = -30 MPa. τ_{12} = 40 MPa.

Useful data: E_1 = 181 GPa, E_2 = 10.3 GPa, G_{12} = 7.17 GPa, and υ_{12} = 0.28.

3. A unidirectional lamina is loaded (as shown in the Fig. 1) under a uniaxial stress $\sigma_1 = \sigma_0$ and principal strains ε_1 and ε_2 are measured. Compute the transverse strain ε_2' of the same lamina when loaded under equal biaxial normal stresses $\sigma_1 = \sigma_2 = \sigma_0$ as function of strains ε_1 and ε_2 obtained before and the modulus ratio k_E = E_1/E_2. 8 CO2

(*Continued*)

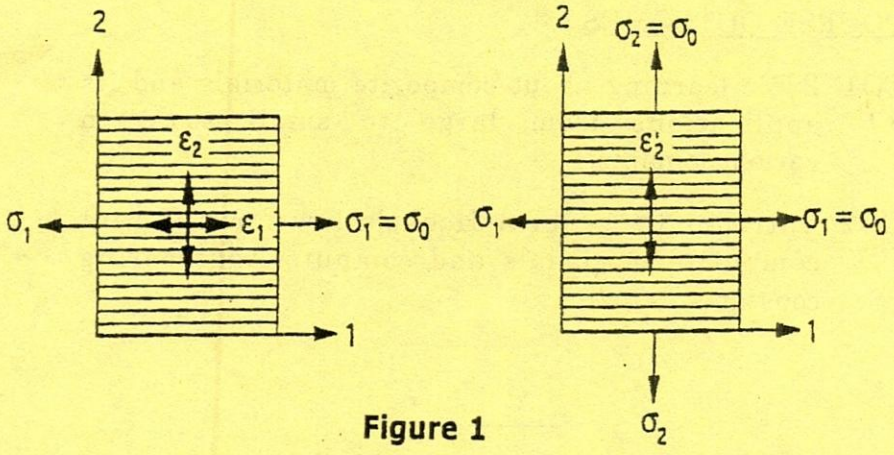

Figure 1

4. A cylindrical pressure vessel with hoop wound fibers (having diameter D = 100 mm, thickness h = 5 mm, made of unidirectional lamina) was loaded with internal pressure p = 20 MPa as shown in the **Figure 2** and gave the following strain readings: $\varepsilon_x = 8 \times 10^{-3}$ and $\varepsilon_y = \varepsilon_\theta = 2.75 \times 10^{-3}$. Assuming $\upsilon = 0.3$, determine lamina moduli E_1, E_2 and G_{12}. 8 CO2

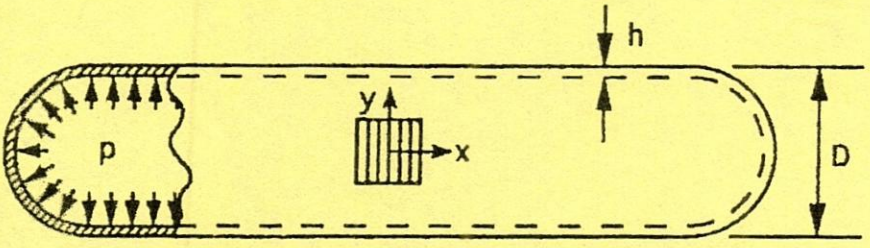

Figure 2

COURSE OUTCOMES

CO1: Basic learning about composite materials and its applications from large to small scale in variousdomains.

CO2: Introducing general Hooke's law for different composite materials and compute Engineering constants.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Odd Semester Mid-term Examination, 2022-23

Course Code: MEE623

Course Name: Multiphase Flow and Heat Transfer

Question Paper No.: NITDGP/MEE623

Full Marks: 25

Time: 90 Minutes

Date of Exam: 22/02/2023

Instructions: Answer question no 1 and any four from rest.

Question No.	Body of the Question	Marks	Mapped CO
1	A rod of 20 cm length is connected to two constant temperature 200^0 and 40^0C at the two end. Find the rod inside temperature solving steady heat conduction equation by finite volume technique. Take constant thermo physical property of rod and also consider three nodes inside the rod.	5	CO2
2	What do you mean by developing flow? Give the example of uniform flow with elaborate discussion.	5	CO1
3	Convert the 2D momentum equation from dimensional to non-dimensional form considering flow over a flat plate.	5	CO2
4	Derive the Prandlt boundary layer equation.	5	CO2
5	Write the difference between Finite volume method and finite difference method with example.	5	CO2
6	Define the continuous and discontinuous flow. Write the difference between single and multi-phase flow with suitable example.	5	CO1

Course Outcomes

- CO1: Understanding the principles of multi-phase flow and heat transfer
- CO2: Relate the fluid-dynamic involved in convection and multi-phase heat transfer.
- CO3: Plan elementary analysis of most gas-liquid two-phase systems.
- CO4: Analyze the model to a wide variety of complex engineering problems.

NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

Even Semester Mid-term Examination, 2022-23

Course Code: MEE 625 Full Marks: 25

Course Name: Computer Aided Design and Manufacturing Time: 90 Minutes

Question Paper No.: NITDGP/MEE625/1 Date of Exam: 22/02/2023

Instructions: Answer all the questions.

Ques No.	*Question*	*Marks*	*Mapped CO*
1	(a) Mention three most important benefits of CAD-CAE to machine design activities.	1	CO1, CO2
	(b) What do you mean by synthetic curve and analytic curve. Briefly explain interpolation technique and approximate technique in respect of synthetic curve construction. Also mention use of synthetic curves.	3	
	(c) Derive the equation of a Bezier curve of degree 'n'. Find the equation of a Bezier curve which has starting and ending points (2, 3, 0) and (4, -3, 0) respectively and is controlled by P_1(6, 6, 0) and P_2(8, 1, 0).	4	
	(d) Explain with suitable example, geometry and topology in connection with solid modeling.	2	
2	(a) State the difference between Bezier curve and cubic-spline curve.	1	CO2
	(b) What is the difference between geometric transformation and coordinate transformation?	1	
	(c) Derive the parametric equation of cubic spline. Find a parametric equation of cubic spline that starts at (1, 2, 0), ends at (9, 3, 0) and passes through two points (2, 4, 0) and (7, 6, 0). Use chord approximation method.	4	
	(d) What do you mean by concatenation of transformations? Explain it with suitable examples where it would be required.	2	
3	(a) Mention two important advantages of solid model over wireframe model.	1	CO2
	(b) Briefly explain the sweep and loft feature in solid modeling.	1	
	(c) Derive the composite homogenous transformation matrix for rotation of point (10, 8) about a point (3, 2). Perform an anti-clockwise rotation of 30° of the triangle A(1,1), B(2,3), C(5,2) about (-1,-1). Find the new co-ordinates of the vertex of the above triangle.	5	

Course Outcomes

CO1: Able to understand scope and application of CAD/CAM tools in industry

CO2: Able to learn geometric modelling and computer graphics concept in CAD tools

CO3: Able to understand the different design analysis and optimization tools in CAD.

CO4: Able to understand the fundamentals of Additive manufacturing, CNC machine tools, Part programming, Industrial Robot etc